

**OIL AND GAS EXPLORATION AND SUSTAINABLE
ENVIRONMENTAL MANAGEMENT IN OIL BLOCK 13T SOUTH
LOKICHAR BASIN, TURKANA COUNTY, KENYA**

By

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**A Thesis Submitted in Fulfillment of the Requirements for the Award of
Degree of Doctor of Philosophy in Environmental Planning and
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University**

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university or any other award.No part of this work should be reproduced without prior permission of the author and /or Kenyatta University.

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DEDICATION

To my loving wife

Grace Mugendi

and my adorable daughter

Hadassah Imani Mugendi

for your love,prayers,moral and emotional support throughout my study period.

May the Lord God Almighty shine his face upon you.

May he bless you and keep you dear ones.

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ABSTRACT

Commercial oil and gas was discovered in Kenya in 2012. Few academic studies have been done on the effects of the mentioned discovery to the environment. The oil and gas resources are expected to transform the economic wellbeing of the locals and the nation at large. However, land degradation, environmental pollution and socio-economic problems have always ensued oil and gas exploration ventures globally. This study aimed at determining the effects of oil and gas exploration on biophysical and socio-economic environments in Oil Block 13T South Lokichar Basin, Turkana South-subcounty and come up with sustainable environmental management strategies in the oil fields. The specific objectives were to review, constitutional, policy, legal and institutional framework governing environmental management in the backdrop of oil and gas exploration in Kenya and determination of oil and gas exploration effects on biophysical and socio-economic environments in the study area. The study adopted an exploratory mixed method research design. Purposive non-probability sampling was applied in determining the study area, sampling the boreholes, sampling the drill cutting samples and sampling the key informants. Probability sampling was used in identifying the manyattas, households and the villages for conducting focused group discussions. Questionnaires, documents review, photography, observation, landsat satellite imageries acquisition and analysis, laboratory analysis using XRF and AAS machines, for drill cuttings and water samples respectively to determine the levels of physicochemical properties were the data collection methods used. The questionnaires were coded into the Statistical Package for Social Sciences version 20.0 software and Excel 10.0. Descriptive and inferential statistics were used in data analysis. The study identified several gaps in the existing environmental policy and legal framework in relation to the oil fields environmental management coupled with poor enforcement of the laws by the relevant agencies. In addition, the study observed a decline in NDVI from 1 to 0.4329 for the rainy season and 0.4107 to 0.1217 for the dry season between 2006 and 2017 with a p-value of $0.0091 < 0.05$ on paired T-test implying a significant change on vegetation cover. The area under forest, shrubland and grassland had significantly reduced at 90% confidence interval with a value of, 0.0718, 0.0738 and 0.0609. The drill cuttings whose levels of detected heavy metals concentration for Manganese (Mn), Copper (Cu), Nickel (Ni), Iron (Fe), Calcium (Ca), Lead (Pb), were; 1.58, 0.21, 0.05, 70.4, 62.57, 4.58 respectively were incorrectly being managed onsite. Mn, Fe and Pb concentration levels in the drill cuttings were above the WHO and USEPA recommended standards for the reserve pit. The levels of Fe, Ni, Turbidity and Total Dissolved Solids of the sampled water from the study area, were all above the prescribed WHO standards. The study noted improved socio-economic characteristics, physical and social infrastructures in the study area. 70% of the respondents felt that water provision, health facilities, education facilities, employment opportunities had improved since oil and gas exploration began with a Cohen kappa coefficient of agreement of 0.608. However, challenges such as population influx, land displacement, lack of adequate engagement of the locals, gender inequalities with a Cronbach's Alpha of reliability of 0.735, health challenges of the locals and increased number of conflicts cases since 2012 with a statistical p-value of $0.005 < 0.05$ were noted. The study recommends enforcement of the existing environmental legislations and development of oil specific environmental laws, adoption of advanced oil drilling and

drill waste management technologies, as well as participatory environmental management approach in the oil fields.

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ACRONYMS

NGOs	Non Governmental Organisations
NEMA	National Environmental Management Authority
KNBS	Kenya National Bureau of Statistics
EMCA	Environmental Management Coordination Act
ECCL	Environmental and Combustion Consult
DHIS	District Health Information Systems
CGT	County Government of Turkana
AOL	African Oil Limited
ADB	African Development Bank
ASAL	Arid and Semi arid Land
EMP	Environmental Management Plan
OPEC	Organisation of Petroleum Exporting Countries
VOC	Volatile Organic Compound
USDSR	United State Departmental State Report
BP	British Petroleum
HDPE	High-Density Polyethylene
ISB	Integrated Support Base
PS	Performance Standards
KPR	Kenya Police Reservist
CSRs	Corporate Social Responsibilities
SLA	Sustainable Livelihood Approach
GIS	Geographical Information Systems
KPMG	Klynveld Peat Marwick Goerdeler (Accounting Firm)

IEA	International Energy Agency
AAS	Atomic Absorption Spectrophotometry
PAH	Polycyclic Aromatic Hydrocarbons
AHP	Aliphatic Hydrocarbons
WRA	Water Resource Authority
LAPSSET	Lamu Port, Southern Sudan, Ethiopia Transport Corridor
NOCK	National Oil Cooperation of Kenya
NDVI	Normalized Difference Vegetation Index
TDU	Thermal Desorption Unit
TM	Thematic Mapper
ETM	Enhanced Thematic Mapper
IFAD	International Fund for Agricultural Development
MEAs	Multilateral Environmental Agreements
DFID	Department for International Development
USEPA	United State Environmental Protection Agency
PPM	Parts Per Million
OLI	Operational land imagery
TIRS	Thermal Infrared Sensors
SGS	General Society Surveillance
IFC	International Finance Cooperation
FIPC	Free Informed Prior Consent

MOEP	Ministry of Energy and Petroleum
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
WBG	World Bank Group
LC	Local Content
NIR	Near Infra Red
pH	Potential of Hydrogen
RoK	Republic of Kenya
SPSS	Statistic Package of Social Sciences
TDS	Total Dissolved Solids
USDI	United States Department of the Interior
WBG	World Bank Group
WMO	World Meteorological Organisation

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Exploration of oil and gas has been in existence since 2,000 BC (Bainomugisha *etal.*,2006).The first modern oil and gas exploration and drilling was done in Titusville, Pennsylvania in 1859. It triggered a significant explosion in the oil and gas industry and this marked the beginning of the current oil and gas industry (Crain,2000).The top three oil-producing countries in the world are Saudi Arabia, Russia and the United Arab Emirates (Harvey,2000).According to ADB (2009),oil history in post-independent Africa stretches over a period of six decades.The report indicates that 16 of the 54 countries in Africa are exporters of oil and 4 of these countries, i.e., Angola,Algeria, Nigeria, and Libya are members of the Organisation of the Petroleum Exporting Countries (OPEC).East African countries have depended on agriculture as the primary economic activity for a long time until 2006 when oil was discovered in Uganda.The golden jubilee commemoration of 9th October 2012 in Uganda coincided with a critical milestone in the country's history; which is the discovery of commercially viable deposits of oil (Purcell, 2014). It is worth to note that though commercial oil quantities discovery happened in Kenya in 2012, exploration surveys had been carried out previously since 1960s with no significant commercial oil quantities success as summarised in Table 1.1 below

Table 1.1: Exploratory and Appraisal wells drilled in Kenya between 1960-2015

Well	Year	Operator	Well type	Block	Basin	Encountered
Pandangua-1	1960	BP/Shell	Exploration	L-4	Lamu	Gas shows in tert.
Walu-1	1960	BP/Shell	Exploration	L-4	Lamu	Dry hole
Meri-1	1961	BP/Shell	Exploration	3B	Anza	Dry hole
Mararani-1	1962	BP/Shell	Exploration	L-3	Lamu	Fluorescence in tertiary (dry well)
Ria Kalui	1962	Mehta & Co.	Exploration	L-19	Lamu	Oil stains
Walu-2	1963	BP/Shell	Exploration	L-5	Lamu	Fluorescence in cret.
Dodori-1	1964	BP/Shell	Exploration	L-13	Lamu	Gas shows in tert/cret.
Wal Merer	1967	BP/Shell	Exploration	L-1A	Lamu	Gas shows in cret.
Garissa 1	1968	BP/Shell	Exploration	L-1A	Lamu	Dry hole
Kipini-1	1971	BP/Shell	Exploration	L-6	Lamu	Fluorescence and Gas shows in tert/ cret
Pate-1	1971	BP/Shell	Exploration	L-4	Lamu	Gas shows in Eocene
Hargaso-1	1975	Texas Pacific Kenya DIV	Exploration	L-1B	Lamu	Gas shows in cret.
Anza-1	1976	Chevron	Exploration	3A	Anza	Oil stains in cret.
Bahati-1	1976	Chevron	Exploration	3B	Anza	Oil stains in cret.
Simba-1	1978	Total Kenya	Exploration	L-9	Lamu	Gas shows in tert /cret.
Maridadi-1	1981	Kenya Cities Service Inc.	Exploration	L-6	Lamu	Dry hole
Maridadi-1A	1981	Kenya Cities Service Inc.	Exploration	L-6	Lamu	Dry hole
Maridadi-1B	1982	Kenya Cities Services Inc.	Exploration	L-6	Lamu	Gas shows in tert.

Maridadi-1B	1982	Kenya Cities Service Inc.	Exploration	L-6	Lamu	Dry hole
Kofia 1	1985	Union Oil of Kenya	Exploration	L-15	Lamu	Fluorescence and Gas shows in Tert/ cret
Kencan-1	1986	Petro-Canada	Exploration	L-1A	Lamu	Gas shows
Elgal-1	1987	AMOCO	Exploration	2A	Mandera	Dry hole
Elgal-2	1987	AMOCO	Exploration	2A	Mandera	Dry hole
Bellatrix-1	1988	AMOCO	Exploration	10A	Anza	Dry hole
Ndovu-1	1988	Total Kenya	Exploration	9	Anza	Gas shows in cret
Sirius-1	1988	AMOCO	Exploration	10A	Anza	Dry hole
Chalbi-3	1989	AMOCO	Exploration	10A	Anza	Dry hole
Duma	1989	Total Kenya	Exploration	9	Anza	Gas shows in cret.
Endela-1	1989	AMOCO	Exploration	3A	Anza	Gas shows in Paleogene
Hothori-1	1989	AMOCO	Exploration	2B	Mandera	Fluorescence and Gas shows in tert/ cret
Kaisut	1990	Total Kenya	Exploration	9	Anza	Dry hole
Loperot-1	1992	Shell	Exploration	10BB	Tert. Rift	Gas and Oil shows
Eliye Spring	1992	Shell	Deviated Exploration	10BA	Tert. Rift	Dry hole
Pomboo-1	2007	Woodside	Exploration	L-5	Lamu	Dry hole
Bogal-1	2010	CNOOC	Exploration	9	Anza	Minor Gas shows
Mbawa-1	2012	Apache	Exploration	L-8	Lamu	Gas shows in cret sandstones
Ngamia 1/1A	2012	Tullow Kenya	Exploration	10BB	Tert. Rift	Oil discovery
Twiga South-1	2012	Tullow & Africa Oil	Exploration	13T	Tert. Rift	30m of net oil pay
Kiboko-1	2013	Anadarko	Exploration	L-11B	Lamu	Dry hole

Kubwa-1	2013	Anadarko	Exploration	L-7	Lamu	Non-commercial oil shows
Agete-1	2013	Tullow Kenya	Exploration	13T	Tert. Rift	100m of net oil pay
Bahasi	2013	AFRICA OIL	Exploration	9	Anza	Minor Gas shows
Ekales-1	2013	Tullow Kenya	Exploration	13T	Tert. Rift	Oil discovery
Ekales-2	2013	Tullow& Africa Oil	Deviated appraisal	13T	Tert. Rift	60-100m of net oil pay
Etuko-1	2013	Tullow& Africa Oil	Appraisal	10BB	Tert. Rift	Oil discovery
Paipai-1	2013	Tullow Kenya	Exploration	10A	Anza	Oil shows
Amosing 1	2013	Tullow Kenya	Exploration	10BB	Tert. Rift	160-200m of net oil pay
Sala-1	2014	Africa Oil	Exploration	9	Anza	Gas discovery and oil shows
Sala-2	2014	Africa Oil	Exploration	9	Anza	Dry hole
Sunbird-1	2014	Africa Oil	Exploration	L-10A	Lamu	Oil and Gas shows
Agete-2	2014	Tullow Kenya	Appraisal	13T	Tert. Rift	Dry hole
Amosing-2	2014	Tullow Kenya	Appraisal	10BB	Tert. Rift	Oil
Amosing-2A	2014	Tullow Kenya	Deviated appraisal	10BB	Tert. Rift	Oil
Ekosowan-1	2014	Tullow Kenya	Exploration	10BB	Tert. Rift	Oil shows
Ekunyuk-1	2014	Tullow Kenya	Exploration	10BB	Tert. Rift	5m of net oil pay
Emong-1	2014	Tullow Kenya	Exploration	10BB	Tert. Rift	Dry hole
Etom-1	2014	Tullow Kenya	Exploration	13T	Tert. Rift	Oil discovery
Badada-1	2015	Lion Petroleum	Exploration	2B	Mandera	Dry hole

Heya (2011), observes that the National Oil Cooperation of Kenya initiated an internal study of the Lamu Basin as part of a continuing plan to reappraise the geological,

geophysical and geochemical data relating to each of the sedimentary Basins in Kenya. In 1995, the Lamu Basin study was completed and was divided into 12 blocks. The Tertiary Rift study was commissioned in August 2000 and ended in March 2001. Tertiary Rift Study led to quantification of the probable source and reservoir rock units in the study area as well as the petroleum system at play in the Sub-Basins. There are four sedimentary Basins in Kenya as per January 2018; that is the Lamu Basin covering an area of 252,297.65 Km², Anza Basin with 94,220 Km², Mandera with 51,920 Km² and Tertiary Rift Valley Basin with 116,619.13 Km² (WBG, 2016). The government of Kenya through the Ministry of Petroleum and Mining in 2016 gazetted 63 oil blocks in all the Basins in the country under Kenyan Gazette notice, No. 3344. The Lamu Basin was gazetted to have 37 oil blocks, Anza Basin has 7 blocks, 5 in the Mandera Basin, and the Tertiary Rift Basin was gazetted to have 14 oil blocks (RoK, 2016). See figure 1.1 below.

As noted in Table 1.1 above the first commercial quantity oil was discovered in Kenya in 2012 by British firm Tullow BV Kenya Ltd. in Tertiary Rift Basin in Oil Block 13T South Lokichar Basin in Turkana County in Ngamia 1. As per December 2017, the Tertiary Rift Valley Oil Block 13T South Lokichar Basin had a total of 38 (exploratory and appraisal wells) drilled (Tullow PLC, 2018). Pre to the discovery of oil and gas Kenya had only experienced much of the oil-related activities through the oil refinery plant in Changamwe, in the coastal region that dealt with the refining of imported crude oil until October 2013, when the refinery was converted to refined oil and gas storage facility (Johannes *et al*, 2017).

The oil discovery in Kenya, is expected to have many positive effects on the socio-economic status of the locals (Johannes *et al*, 2017). However, there are major deleterious concerns worldwide as noted by Plänitz & Kuzu (2015) associated with oil and gas

exploration on both biophysical and socio-economic environment around the oil fields. These effects range from land degradation, water, and air pollution to adverse effects on community's sources of livelihoods, hence the need for sustainable approach in the management of these environmental aspects around the oil fields.



Operators:			
1	Afren EAX	11B	Adamantine
2A	Simba Energy	12A	Tullow
2B	Lion Petroleum	12B	Tullow
3A	Vanoil	14T	NOCK
3B	Vanoil	L-1A	A-Z Petroleum
9	Africa Oil Corp. (unlicensed)	L-1B	CAMAC Energy
10A, 10BB	Tullow	L-2	Imara Energy
11A	CEPSA	L-3	A-Z Petroleum
		L-4	Zarara Oil & Gas
		L-5	Anadarko
		L-6	FAR Ltd.
		L-7	Anadarko
		L-8	(under negotiation with Pancontinental)
		L-9	Ophir Energy
		L-10A, L-10B	BG Group
		L-11A, L-11B	Anadarko
		L-12	Anadarko
		L-13	Zarara Oil & Gas
		L-14	Lamu Oil & Gas
		L-15	(relinquished)
		L-16	CAMAC Energy
		L-17, L-18	Afren EAX
		L-19	Rift Energy
		L-20	Pacific Seaboard Investments
		L-21	Eni
		L-22	Total
		L-23, L-24	Eni
		L-25, L-26	(open)
		L-27, L-28	CAMAC Energy

Figure 1.1. Oil blocks in the four sedimentary rock Basins in Kenya and the Oil exploring companies as at December 2017 (Source: RoK, 2017)

According to Lin (2009) sustainable environmental management strategies has been a mirage in many oil-producing countries. He further notes that the focus has been on oil resource and its economic benefits with little attention on ecological effects and its implication on the pre-existing sources of livelihoods. As a result, the degraded ecosystems affect people's sources of income and trigger conflicts as resources become scarce and as people fight for compensation for their lost resources. Health problems due to water and air pollution and insecurity challenges as people become idle and jobless may also arise (Kadafa & Ayuba, 2013). A closer examination of the study area focused on a study done by Opiyo, *etal.* (2015), which notes that the Block 13T, South Lokichar Basin is among the arid and semi-arid regions in Kenya with a harsh environmental condition unsuitable for rain-fed agriculture. They further point out that pastoralism is the primary economic activity of the communities dwelling in this area; hence sustainable management of water, land and vegetation resources are of paramount importance. Changes such as the ones highlighted by Plänitz & Kuzu (2015) in Niger delta context as a result of oil and gas exploration activities would have extremely negative implications for the well-being of the locals in the study area. This observation is consistent with Odote (2014) who notes that sustainable environmental management strategies are very vital in the region even as the oil and gas exploration activities intensifies.

1.2 Statement of the Problem and Justification

Commercial quantities crude oil discovery was first made in Kenya in 2012 in Oil Block 13T South Lokichar Basin, Turkana county (WBG, 2015). This discovery is expected to have many positive implications on socio-economic status of the locals in both Turkana County and the country at large. Studies done by Plänitz & Kuzu (2015), Ajugwo (2013),

Agwu *etal* (2016) and Kadafa & Ayub (2012) in Gabon, Angola, Ghana, Equatorial Guinea and Nigeria respectively have shown that there are several biophysical environmental challenges such as land degradation, poor waste management, water, soil and air pollution and negative socio-economic effects such as loss of livelihoods, population influx, loss of jobs, conflicts, crime, health challenges, erosion of culture, dropping out of school due to oil money and land displacement. Therefore, mitigating such challenges from happening in Kenyan context is very important. Globally, several studies have made a plethora of recommendations in management of the environmental challenges resulting from exploration of oil and gas, but sustainable environmental management has always been a mirage.

Agbonifo (2015) points out that many of these challenges are because of ineffective policy and legal framework in many oil and gas producing countries. Despite discovery of commercial quantities in Block 13T South Lokichar Basin in 2012, few academic studies have been carried out in the region to assess the effects of oil exploration on both biophysical and socio-economic environments. Turkana County is an arid and semi-arid region with harsh environmental condition unsuitable for rain-fed agriculture. Pastoralism is the primary source of livelihoods for the locals (Opiyo *etal.*, 2015). Full understanding of the effects of oil and gas exploration in Oil Block 13T South Lokichar Basin will help in developing sustainable environmental management strategies that will safeguard the surrounding natural ecosystems, local culture, resulting social and physical infrastructures, social cohesion and livelihood sources.

Previous studies done in the area assessed the potential effects of oil and gas exploration in Turkana County, and they mostly focused on oil exploration implications on socio-economic characteristics except one that focused on analysis of physical chemical

parameters of drilling cuttings from Oil Block 10B. Odote (2014), Johannes *et al.* (2017) and Mbithe (2016) examined the potential effects of oil and gas exploration on peaceful coexistence among the local communities, potential effects of exploration on the locals' livelihoods and analysis of physical chemical parameters of drill cuttings from Amosing 5 reserve pit in oil Block 10B respectively. However, these studies did not examine a number of issues.

First and foremost Odote (2014) and Johannes *et al.* (2017) adopted systematic review research design of studies done in other oil producing countries cautioning similar trends could be experienced in the Kenyan scene, hence the need for an actual exploratory study to assess and make recommendations on sustainable environmental management against the backdrop of oil and gas exploration in a Kenyan setup. The study done by Mbithe (2016) assessed the chemical composition of drill cuttings from Amosing 5 in Oil Block 10 BB and it did not examine the implication this had to surrounding ecosystems, an issue investigated by this study. None of the studies looked at the land cover changes in Turkana and how it is affecting the pastoral communities, hence the need for this crucial component of this study.

In conclusion, even though Agbonifo (2015) had pointed out that sustainable environmental management has been an illusion over the years due to weak legal and policy frameworks in many oil producing countries globally, few academic studies have been carried out to review the various policies and laws governing oil and gas exploration and environmental management in Kenya, a matter examined in this study. The study therefore, seeks to advance research by examining the role of constitutional, policy, legal and institutional framework in sustainable environmental management in Kenya in the backdrop of oil and gas exploration and benchmark with universally acceptable practices. In addition, the study

examines how the drilling activities in Turkana County have affected the vegetation cover and the implication this has on livestock and wildlife. Moreover the study assesses the waste materials generated from the exploration activities and the potential implications they have on water, soil, air and social environment. Furthermore, the study explores how the oil and gas exploration in Turkana County is affecting the socio-economic characteristics of the locals. It is envisaged that the outcome of this research will help address the biophysical and socio-economic problems associated with oil and gas exploration activities.

1.3 Research Questions

1. Is there an elaborate constitutional, policy, legal and institutional framework governing environmental management in the backdrop of oil exploration in Kenya?
2. To what extent has oil and gas exploration affected the biophysical environment in Oil Block 13T South Lokichar Basin?
3. To what extent has oil and gas exploration affected the socio-economic characteristics of the locals in Oil Block 13T South Lokichar Basin?

1.4 Research Objectives

1.4.1 General Objective

To assess the effects of oil and gas exploration on the biophysical and socio-economic environment in Oil Block 13T, South Lokichar Basin, Turkana County and come up with recommendations that would enhance sustainable environmental management in the oil fields.

1.4.2 Specific Objectives

1. To review constitutional, policy, legal and institutional framework governing environmental management in the backdrop of oil and gas exploration in Kenya.
2. To assess the effects of oil and gas exploration on biophysical environment of Oil Block 13T South Lokichar Basin, Turkana County.
3. To assess the effects of oil and gas exploration on socio-economic characteristics of the communities in Oil Block 13T South Lokichar Basin, Turkana County
4. To develop sustainable environmental management strategies in oil and gas exploration fields in Kenya.

1.5 Research Hypothesis

In assessing the significant effects of oil and gas exploration on biophysical and socio-economic environment, the study hypothesised that:

H₀-There is no significant difference in the NDVI value of the vegetation cover in Oil Block 13T South Lokichar Basin before and after the commencement of oil and gas exploration.

H₀-There is no significant difference in the size of the area under vegetation cover in Oil Block 13T South Lokichar Basin before and after the commencement of oil and gas exploration.

H₀:There is no significant change in the level of establishment of social and physical infrastructures before and after oil and gas exploration commencement.

H₀ There is no significant difference in income earned by the locals before and after oil and gas exploration began in Oil Block 13T South Lokichar Basin.

Ho There is no significant difference in revenues generated by the various business investors in Lokichar town before and after the commencement of oil and gas exploration.

Ho There is no significant difference in the average number of social-environmental conflicts cases reported before and after the commencement of the oil and gas exploration in Oil Block 13T South Lokichar Basin.

1.6 Significance of the Study and the Expected Output

Few academic studies have been done in Kenya on the effects of commercial oil and gas exploration on the environment and its management since it is quite a new venture in the country. This study is an exploratory research since the findings from the study will provide the baseline information for further studies in evaluating the effects of oil and gas exploration on the socio-economic and biophysical environment and their management. Findings from this study will also be crucial to the environmental management regulatory bodies for they will be used to identify gaps in enforcement, monitoring and evaluation of environmental management in oil and gas exploration fields. The study findings will also be key to the policymakers for they will guide in reviewing and developing new policies and legislations on sustainable environmental management in oil and gas exploration fields in Kenya. Besides, Kenya is a signatory to the sustainable development goals, and the findings of this study will contribute to the body of knowledge that will help in diverse policies formulation that are very instrumental in the realisation of sustainable development goals number three on good health status for all, goal number five on gender equality, goal number six on clean water and sanitation, goal number thirteen on climate action, goal number fifteen on sustainable terrestrial land management and goal number sixteen on peace and justice for all. The Kenya vision 2030 summarises

the significance of sustainable environmental management for the present and future generations. Therefore, this study fits very well with national and global development agenda for sustainable environmental management.

1.7 Limitations

Several limitations were encountered during this study. The first limitation was the accessibility of the study area. By the time this study was being carried out, the Government of Kenya had embarked on the construction of Kitale-Lodwar highway, therefore, Oil Block 13T South Lokichar Basin was inaccessible by road. Only Lorries and four-wheel drive trucks could ply the route and air transport from Nairobi to Oil Block 13T South Lokichar Basin though expensive became the only option to overcome the limitation. The second limitation was the issue of the language barrier especially in interviewing the local communities whose majority of them lacked formal education; educated local enumerators were engaged to manage the challenge.

The other limitation was access to the sparsely populated homesteads in the study area. The villages were far apart, and the study engaged motorcycles for easy transport services. Another limitation was accessing the drilled well pads that were tightly guarded by the oil companies, and in overcoming the challenge, the researcher did intensive engagement with the main oil exploring company management team who gave some data partly regarding the same. To access the Well pads and sample the mud cuttings waste the researcher collaborated with the local NGOs and community leaders who have a massive influence in the region and whose names did not get mentioned in this study for they sought anonymity. Sampling and transportation of the water samples was also a significant challenge since some parameters needed to be analysed as quickly as possible and the study realised this by taking some measurements such as pH and Turbidity onsite. Air transport was used to

deliver the samples to Nairobi for analyses of the other parameters since there were no laboratory facilities in the study area. The study analysed the heavy metals contents of the water samples using the Atomic Mass Spectrophotometry machine available within the University Laboratories. X-ray fluorescence machine was used for the drill cuttings heavy metals analyses in the Geology and Mining Laboratories, Department of Geology and Mining of Kenya.

1.8 Scope of the Study

The study focused on reviewing the constitutional, environment policy, legal and institutional framework governing environmental management against the backdrop of oil and gas exploration in Kenya. In addition the study assessed the oil exploration effects on biophysical environment in Oil Block 13T South Lokichar Basin and socio-economic characteristics of the locals 6 years before and after the discovery of commercial oil quantities.

In assessing the effect of oil and gas exploration on biophysical environment, the study looked at the land cover changes in Oil Block 13T South Lokichar Basin; Turkana South Sub-County the area hosting the Well pads Ekares 1,2 and Ekares 3, Agete 1 and 2, Etom 1 and 2, Twiga 1 and 2, Ekoswan and Emong which formed the geographical sampling unit. A distance of 10 kilometres radius from the fences of the 11 Well pads was assessed through mapping, acquisition and analysis of Landsat imageries. The effects of the vegetation clearance on wildlife and livelihoods around the Well pads were examined. The study also covered the analysis of community water boreholes in the study area and a total of four community water boreholes that existed in the area pre and post oil and gas exploration commencement were sampled and analysed for physical properties and heavy metals content in the water. Drill cuttings from Twiga 1 Well pad reserve pit temporary

storage facility were sampled and analysed too for the selected heavy metals content. Regarding the geographical coverage, for surveying the locals views on the effects of oil and gas exploration on biophysical environment, the study focused on Oil Block 13T South Lokichar Basin, Turkana South Sub-County, a section of Oil Block 13T South Lokichar Basin that falls within Lokichar Ward and this is where the population sample size interviewed got drawn from. On the vegetation cover degradation, the study narrowed down to an area 10 kilometres equidistance from the eleven Well pads aforementioned. The study also looked at the effects of oil and gas exploration on soil depending on secondary data, air pollution around the study area focusing on dust, light pollution and people's attitudes on temperature changes and noise pollution.

Under socio-economic theme, the study looked at the income and employment of the locals before and after the oil and gas exploration activities began. Arising conflict cases, health challenges specifically respiratory tract, skin, eye and new HIV infections, vis-à-vis the situation of these cases before the oil and gas exploration began and the statistics from other Sub-counties of Turkana County and the neighbouring Samburu County. Compensation for land displacement cases, population influx and different income sources of the locals. In addition, the study looked at the effects of oil and gas exploration on animal migration routes, level of public participation in decision making in the area, effects on business and urban area growth. The study also examined the effects of oil and gas exploration on establishment of social and physical infrastructures and services such as, roads, security and services, education facilities and services, health facilities and services, water facilities and services. The study assessed these various variables and made recommendations on how sustainable environmental management strategies can be achieved.

1.9 Study Assumptions

The study assumed that the changing physical chemical parameters of the community boreholes water was due to probable contamination from waste materials generated from the oil fields. The other assumption made by the study was that the change in temperatures around oil Block 13T South Lokichar Basin and the increased respiratory, eye and skin infections was due to air pollution from gas, dust emissions and volatile organic compounds from the oil and gas exploration activities. However these assumptions cannot be authoritatively be affirmed since there are a number of factors that can contribute to this pollution (IPCC, 2007).

1.10 Definition of Operational Terms

Oil- A mixture of hydrocarbons which is liquid in nature and is present in sedimentary rock strata. Usually extracted and refined to produce fuels including, paraffin, and diesel oil petrol. The term is used interchangeably with the term petroleum oil (Jarret, 2016).

Environment - A set of interlocking system that is the physical environment system, the biological environment system and social economic environment system (Muthoka *et al.*, 1998)

Upstream- The exploration and production segment of oil and gas resource chain (Herrmann *et al.*, 2010)

Mid-stream- The refinery and storage segment of resource chain (Herrmann *et al.*, 2010)

Downstream- The marketing and distribution segment of oil and gas resource chain (Herrmann *et al.*, 2010)

Exploration- Search by petroleum geologist and geophysicists for hydrocarbon deposits involving exploratory, appraisal and development wells drilling. It comes with a lot of vegetation clearance and excavations (Devold, 2013)

Production- All processes including initial recovery using naturally occurring pressure, secondary or tertiary recovery techniques required for the recovery of petroleum from a reservoir within the earth surface, the separation, initial treatment of the petroleum and bulk transportation (Devold, 2013.)

Block- Large tract of land awarded to oil and gas exploration and drilling companies by the oil resource host Government(MEP, 2015)

Physiochemical- Physical and chemical properties of matter(Stanley *etal.*,2014)

Biophysical environment-Environmental system composed of water, the atmosphere(weather elements) ,soil, animals and vegetation cover(Muthoka *etal.*,1998)

Formation waters- Water that occurs naturally within the pores of rock thought to have petroleum hydrocarbon(Devold,2013)

Manyattas- They are settlement villages for the Turkana people. They are composed of temporally enclosed homesteads and inhabited by one or more families(Opiyo *et al.*, 2015)

Drill/Mud cuttings- They are broken bits of solid rock material generated by the drilling bits during oil and gas explorations and drilling operations. (Akporfure,2011)

Sustainable- Able to be used by the current generation without being destroyed or compromised for future generations' usage (Emas, 2015)

Heavy metals- a metal whose density or relative atomic weight is comparatively high. They include Cadmium (Cd), Nickel (Ni), Manganese (Mn), chromium (Cr), copper and lead (Pb) Potassium (K), Calcium(Ca) (Stanley,*etal.*,2014)

Landsat- They are satellites fortified with sensors able to sense the solar radiation reflected by the earth surface and also infrared light and are used to collect earth's land surfaces imageries data such as vegetation cover (Reddy,2008)

Flaring- Is the measured burning of natural gas encountered during the oil and gas explorations processes(Devold,2013)

Respiratory infections- Infections involving the upper respiratory tract that includes, pneumonia, bronchitis, influenza, common cold, cancer of the respiratory tract and Tonsillitis(Conant & Fadem,2008)

Eye infections- Pain, itching, or sensation of a foreign body in the eyes mostly caused by gases or dust from oil and gas exploration fields(Oppong,2012)

Skin infections- Skin rashes brought about by body reacting to allergens such as gases and chemicals(Oppong, 2012.)

Well pad- It is a cleared zone for a drilling rig to work on a piece of land buffered for oil and gas extraction. The well pad is usually prepared by clearing all trees and vegetation(Devold, 2013.)

Reserve pit- It is an earthen pit dug next to a drilling rig and is generally used for the dumping of drilling muds in oil fields(Devold, 2013)

1.11 Study Outline

The following is an overview of the various chapters contained in each section of this thesis.

Chapter one covers the background of the study; it describes the history of oil and gas exploration at global, regional and local level. It also focuses on the significant challenges that have been attributed to the oil and gas exploration activities all over the world and highlights why the research is being undertaken and its essence in sustainable environmental management in the backdrop of oil and gas exploration. Other parts covered under introduction chapter includes the research objectives, research questions, the

research hypotheses and the statement of the problem. The chapter also covers justification for the study, the significance, study limitations, scope covered by the study, the assumptions made and definition of operational terms used. This chapter provides a roadmap to the study through the issues elaborated in the sub-headings.

Chapter two covers the literature review section with three key themes that is, a review of the constitutional, policy, legal and institutional framework governing environmental management in the backdrop of oil and gas exploration in Kenya, the oil and gas exploration effects on biophysical and socio-economic environments in Oil Block 13T South Lokichar Basin.

The chapter does an overview of the oil and gas exploration processes, and this brief overview highlights the various activities that brings about the effects under investigation. The review endeavors to link these oil and gas exploration activities with the three thematic areas with a view of establishing relationships between them in the realisation of sustainable environmental management strategies. The review also provide the basis for determining the existing theoretical frameworks that are related to the study and also forms the foundation for the conceptual framework adopted for the study.

Chapter three outlines the research methodology that the study adopted. It covers the area of study, the research design used, the sampling procedure and techniques, sample size determination, data collection methods, sampling frame, the data collection tools as well as the data analysis.

Chapter four provides detailed study findings as well as data analysis presentation, and discussion of results. The contents of this chapter include the findings of the review of the existing policy, legal and institutional framework on environmental management and oil and gas exploration sector in Kenya. In addition, the section entails the findings of the

results on the effects of oil exploration on biophysical environment. Finally the section contains the various socio-economic effects resulting from oil and gas exploration activities in Oil Block 13T South Lokichar Basin ,both positive and negative with a critical analysis of each. All the findings are accompanied with thorough interpretation and discussions.

Chapter five covers the summary, conclusion and recommendations of the study. Areas for further research have also been identified at the end of this chapter.

Chapter six and chapter seven outlines the references and appendices respectively.

CHAPTER TWO: LITERATURE REVIEW

2:1 Introduction

The chapter begins with a brief explanation of oil and gas resources in addition to a short exploration description process. This brief exploration process highlights the various activities that bring about the effects under investigation. The discussion in this chapter falls in three thematic areas based on the research objectives. The first thematic area is, a brief review of the constitutional, policy, legal and institutional framework and IFC performance standards on environmental sustainability governing oil and gas exploration and environmental management in Kenya. Full analysis and discussion on this thematic area is done on chapter 4, article 2. In addition, the chapter elaborates on the oil and gas exploration effects on biophysical and socio-economic environments as observed by different researchers globally. The chapter also describes the existing theoretical frameworks that are related to the study, that forms the foundation for the conceptual framework adopted and modified for the study. The study gap is also explained in this chapter.

2.1.1 Oil and Gas Resources

Oil and gas has had a profound impact on the world civilisation than any other single natural resource in recorded history (Ayuba, 2012). According to Plänitz & Kuzu (2015), globally people's lives and nations' economies have been transformed by oil and gas resources. Oil keeps the developed countries working and provides the revenues, which helps the oil exporters to implement their national and economic development plans.

Kumar *etal.*(2013),notes that oil and gas is typically adored for its economic value, with less focus on the ecological effects especially at the exploration stage. He further notes that both upstream and downstream segments of the oil and gas sectors have severe adverse effects on the environment if poorly managed. It affects the three systems of the environment that is, the social, biological and physical aspects.Kenya's late entry into the oil market puts the nation in an excellent position to learn from other countries mistakes on management of the oil and gas fields environments.

2.1.2 Oil and Gas Exploration Process

According to Devold (2013),exploratory drilling is undertaken to verify if geological formations have accumulations of hydrocarbons and if the site can produce enough oil and gas to make it economically viable to proceed with further development.He further explains that it is a temporary and short duration activity, taking between 90 to 120 days under normal condition.Exploratory drilling is carried out by the use of drilling rigs. The drilling process generally uses drilling bits of different sizes to drill a series of concentric holes from the surface to the intended well depth(Aketch,2012).

According to Younes (2012),oil based, water based or synthetic drilling fluids get circulated within the drilling string to the drill bit.The principal purpose of the drilling fluid structure is the removal of clippings from the well and controlling of formation pressures; they also help in sealing permeable formation; keeping wellbore stability;cooling,greasing and supporting the drill bit and transferring hydraulic energy to bit and tools.Chemicals and mud additives usually are mixed to the desired concentrations with water in preparation of the drilling mud.

Fauzi *etal.*(2011) observes that well drilling is usually carried out in segments with the diameter of each section reducing as the depth increases. They further notes that during well drilling bentonite, mixed with water is generally pumped at high pressure down the drill filament to power drill cuttings up the annulus. 30cm conductor is cemented into place to warrant structural integrity of the well. The installation of the wellhead and other necessary equipment is then carried out followed by subsequent well drilling.

Aketch (2012) records that upon the installation of the wellhead and the necessary equipment, the drilling of the subsequent well sections is carried out by circulating drilling mud, and the cuttings returned to the rig for separation of the mud before discharge. A casing is run as each section of the well gets drilled and cemented into place ready for digging the next smaller diameter section. The drill cuttings are reverted to the rig with the circulating mud and passed through a solids control package for separation of the drilling fluids from the cuttings.

According to Ayuba (2012) oil and gas exploration entails activities such as, clearing vegetation to establish access route and site for well pad construction. This is followed by perimeter erection. Other preparation activities include digging of the drilling water reservoirs with a capacity of 6,500 m³ per site for areas not connected to piped water and coating of the pits with HDPE lining material. Excavation of drill cuttings pit, with a standard size of 16 m long x 9 m wide and 3 m depth with a bottom measuring 8 m x 13 m per site is carried out. Fauzi *etal* (2015) notes that the next stage in well exploration is rigging up which entails lumping together and erecting the drilling tower commonly known as the derrick or mast and other accompanying equipment's. The drilling tower is referred to as a mast if the tower is part of a tractor-trailer and is jacked up as a unit or a derrick if constructed on site as shown in Figure 2.1 below. They further note that several

drilling techniques do exist such as cable-tool drilling, auger drilling, rotary drilling, compressed air drilling, rotary drilling with mud and foam/polymer drilling. Rotary drilling is the most common technique used in the developing countries. It entails assorting Bentonite and synthetic stabilizers with water and circulated in the oil well. Circulation of the drilling fluids down the hole through the drill pipe, where it exits through ports in the bit ensues. The drilling fluid flushes the cuttings away from the face of the bit and carries them up the annulus to the surface. When the drill cuttings get to the surface, they do enter the settling tanks where the cuttings are separated from the drilling fluids before it is circulated down the hole again.

The entire exploration process affects the vegetation cover, generate drill waste in form of drill cuttings, natural gases, formation waters, used drilling fluids in addition to interruption of indigenous sources of livelihoods due to land use, land cover changes hence the need for effective policy, legal and institutional framework to ensure sustainable management of the oil and gas fields environments (John Baffes, 2016).

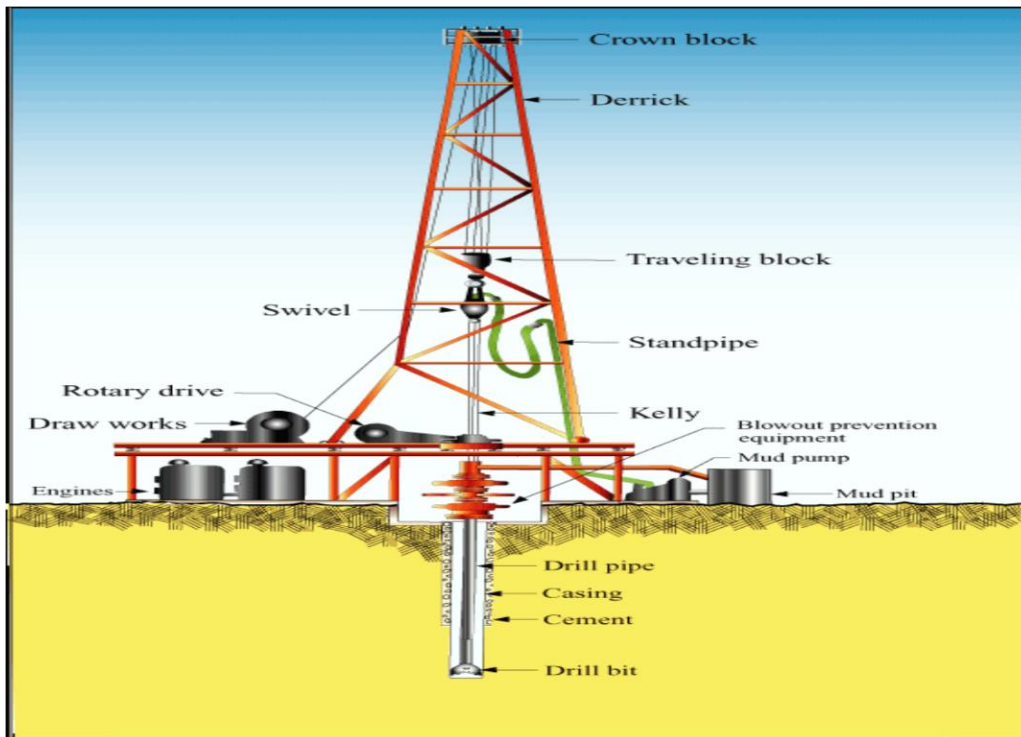


Figure 2.1: Schematic representation of a drilling rig (Source: AOL, 2017)

2.2. Constitutional ,Policy, Legal and Institutional Framework in Oil and Gas Exploration and Environmental Management in Kenya

2.2.1 Introduction

Sustainable development is a policy objective for many countries in the world today. The collection of new policies oscillating from international conventions to national strategies, environmental legislation at all levels of the government, regional plans, and local programs by many countries justifies the commitment. However, scientific evaluation shows that the world is not nearer to sustainable environmental management and in many cases, the circumstances are becoming worse because of inadequate legal and policies implementation (Howes *et al.*, 2017). A systemic study done by Raji & Abejide (2014) on

why sustainable environmental management has been elusive in Niger Delta, identified weak policy and legal framework and poor implementations to be the significant hindrance. Corruption among the institutions of governance has also been reported by Donwa *etal.*(2015) to hamper environmental sustainability.

Kenya has a robust, constitutional, policy and legal framework on matters environmental management. Effective implementation of these regulations will enhance environmental sustainability in the backdrop of oil and gas exploration in Oil Block 13T South Lokichar Basin. This study examined this objective in this section in the following order, the national policies governing environmental management in the backdrop of oil exploration, the institutions of governance, legislations and constitutional framework, the MEAS and the IFS performance standards with full analysis of the same being shown in chapter 4, section 4.2

2.2.2 Environmental Policy on Oil and Gas Exploration in Kenya

The study reviewed various local policies that are related to environmental management within the backdrop of oil and gas exploration. The policies reviewed in this section entails; the National Environmental Policy 2013, National Energy and Petroleum Policy 2015, National Land Policy 2016, National Policy for Northern Kenya and other arid lands 2012, National Forest Policy 2014. Detailed analysis of these policies in reference to the Constitution of Kenya 2010, legal framework and practical implementation of the mentioned policies in Oil block 13T, South Lokichar Basin is shown in chapter 4, section 4.2.1

2.2.2.1 National Environment Policy 2013

The National Environment Policy 2013 of Kenya was developed to achieve several objectives. The system provides a framework for an integrated method to planning and sustainable management of Kenya's natural resources and the environment. Chapter 4, article 6 stipulates that the government must ensure the implementation of the constitution for a clean and healthy environment. The policy requires the government to support research and capacity expansion as well as the use of inventive environmental management methods such as payment for ecosystem services, disincentives, incentives, environmental impact assessment and total economic valuation, indicators of sustainable development, strategic environmental assessments and environmental audits. In addition, the Policy requires the Government to promote and improve cooperation and partnerships in the sustainable management of the environment and natural resources and ensure inclusion of evolving issues such as infectious diseases, gender, poverty reduction and environmental diseases that may affect environmental management.

The government is also expected to promote coordination and domestication of strategic Multilateral Environmental Agreements (MEAs) through NEMA and Directorate of the Environment. The Policy calls for the right to development while considering environmental and socio-economic sustainability. Chapter 4, article 1 requires that the Government ensures environmental restoration and that environmental, natural resources utilisation happens in a sustainable manner without compromising the quality of the resource or diminution of the carrying capacity of supporting ecosystems. Chapter 4, article 8 emphasises on sustainable mining and the principle of equity, for it calls for the equitable access to resources for present and future generations. The Policy calls for public

participation in environmental protection and management to ensure that the appropriate County Government Agencies, National Governments, civil society, private sector and communities are involved in planning, implementation and decision-making practices. Precautionary principle and polluter pay principles are key guiding principles of the Kenyan Environment Policy framework 2013. Also, good governance, respect for human rights and the meaningful participation of citizens should be integrated into environmental management, effective institutions, transparency and accountability, benefit sharing of environmental resources and community empowerment. Chapter 5.6 requires the commencement of infrastructures development. The locals should be engaged in the planning and approval processes. Chapter 6.1 outlines the need for air quality and calls for the implementation of international strategic integrated chemical management in development plans. Chapter 6.2 calls for improvement on the management and conservation of water sources, with chapter 6.3 and 6.5 calling for proper waste including toxic/hazardous material management. Chapter 6.6 demands a national strategy on noise pollution while chapter 6.7 and 6.8 calls for the integration of fight against environmental diseases caused by air or water pollution and other diseases caused by population influx in environmental protection programme. The government should ensure safe water and should build essential environmental public health infrastructures.

2.2.2.2 National Energy and Petroleum Policy 2015

The policy sole aim is to ensure that there is, adequate, sustainable, competitive, reliable, secure and adequate supply of energy within the country while conserving and safeguarding the environment. This policy aligns with the Kenya's Constitution 2010. The policy has defined several action plans. The main emphasis of these action plans are on;

environment, land, health and safety, devolution and provision of petroleum energy services, energy financing, social, economic issues, gas sector development policies among other cross-cutting issue.

2.2.2.3 National Land Policy 2016

The policy recognises the private land ownership and 'Trust land' that was amended to the community land in line with Constitution of Kenya 2010. The policy calls for the development of a participatory process in leasing out of the community land and incorporation of the customary mechanism of conflict resolution. The policy stipulates the formation of community land boards to regulate and manage the access to community land. The board has to be elected by the community. However, the work of the board seems to overlap with the responsibilities of the community land management committee anchored in the Community Land Act 2016.

2.2.2.4 National Policy for Northern Kenya and Other Arid Lands (2012)

The sole aim of the policy is poverty reduction among the local communities. The Policy aims at management of overgrazing and improves natural resource, key among them, the forage management. Moreover, the policy seeks to reduce the perpetual insecurity in the area and ensure proper management of the scarce water resource regarding quality and quantity.

2.2.2.5 National Forest Policy 2014

The main objectives of the National Forest Policy 2014 as stipulated in Chapter 3.2 are to increase and sustain forest and tree cover of at least 10% of the land area of Kenya. The

second objective is to institute a supporting legislative and institutional framework for improvement of the forest sector. In addition, the policy seeks to regulate and encourage support in funding forestry research, training, education, information generation and distribution, and technology transfer for sustainable development. The policy also aims at promoting private, public and community participation and partnership in development of forest sector. The other objective of the policy is to promote investment in commercial tree growing, forest industry and trade, improve management of forest resources for preservation of water biodiversity, soil and ecosystem balance. Turkana County falls under the ASAL areas of Kenya and the predominant vegetation cover is dry land forest vegetation. There is no gazetted forest in the county (RoK, 2018). Chapter 4, article 3 outlines the essence of the dry land forest vegetation found in the area. The article further supports the rehabilitation of degraded dry land forests and encourage planting of indigenous species trees in the arid and semi-arid lands. It also requires the promotion of conservation of genetic resources in dry land forests. See more analysis in chapter 4, article 2.

2.2.3 Institutions of Governance in Oil and Gas Exploration and Environmental Management in Kenya

Several institutions shall be involved in the management of environment in the backdrop of oil and gas exploration in Kenya. The study briefly identified some of these institutions in this section. However, detailed analysis is shown in chapter 4, section 4.2.3. The study examined the following institutions; The Ministry of Petroleum and Mining, National Oil Cooperation, National Land Commission, National Environmental Management Authority

,Energy Petroleum and Regulatory Authority ,Directorate of Occupational Safety and Health Services, Water Resources Authority and Kenya Maritime Authority.

The Ministry of Petroleum and Mining represents the Government in matters relating to petroleum, licensing of the oil blocks, and mining activities. The Ministry of Environment and Forestry through several Government agencies oversees the aspects of environmental management in the backdrop of oil and gas exploration. National Oil Cooperation (NOCK) is a state cooperation, and it is responsible for upstream of oil and gas exploration together with other licensed private oil and gas exploring companies. Another key institution affiliated to the management of issues related to oil and gas exploration sector in Kenya is the National Land Commission which is an organ established by the Constitution of Kenya 2010. The Commission administers public land on behalf of the government. Another key institution is the National Environmental Management Authority established under EMCA (CAP 387). The authority in partnership with other agencies coordinates environmental management activities and the integration of environmental considerations in development plans. The Energy and Petroleum Regulatory Authority is a key lead agency in the energy and petroleum sector. The lead agency is the implementing agency for the Energy Act 2019 and it is the body that does formulate, implement and review environmental, health, safety and quality standards for the energy sector, in harmonisation with other constitutional authorities. The Energy Act 2019 stipulates that while reviewing the applications for licenses in the sector, the UPRA should ensure compliance with EMCA (CAP 387) on environmental and social effects by the applicants.

Other authorities that have a regulatory mandate in the energy and petroleum sector on matters of environment, health and safety are the Directorate of Occupational Safety and Health Services (DOSHS) which is the lead agency for the Occupational Safety and Health

Act of 2007. Another agency is the Water Resources Authority (WRA) under Water Act of 2016 and should monitor and evaluate the water resources to ensure that it is safe for human consumption in partnership with other agencies. Another agency is the Kenya Maritime Authority (KMA) under the Merchant Shipping Act & Kenya Maritime Authority Act of 2006. The Petroleum (Exploration Development and Production) Act 2017 is expected to establish the Upstream Petroleum Regulatory Authority, which will be the regulatory agency for the upstream petroleum operations, and the Upstream Petroleum Advisory Committee to provide oversight to the regulatory agency. See more analysis in section 4.2 of this thesis report.

2.2.4 Constitutional and Legal Regulatory Framework in Oil and Gas Exploration and Environmental Management in Kenya

There are several legislations in Kenya that if implemented by the lead agencies would ensure sustainable environmental management. The main environmental management legislations in the oil and gas exploration sector in Kenya examined in this section with full analysis in chapter 4 section 4.2.2 include the Kenya's Constitution (2010) EMCA (CAP 387), Petroleum Act 2019 besides international conventions and treaties that have become parts of the Kenyan laws according to Kenya's Constitution 2010, Article 2(6) and other international performance standards majorly the IFC performance standards. The overarching environmental legislations in oil and gas exploration in Kenya are the Constitution of Kenya 2010 and EMCA CAP. 387.

Chapter 4 of the Kenya's Constitution 2010, Article 40 states that every person has the right, either individually or in association with others, to acquire and own property. Article 40(3b) (i) requires prompt payment in full of just compensation to the person whose land

has been deprived by the state. Article 40(4) states that provision may be made for compensation to be paid to occupants in good faith of land acquired which is the bill of right Article 42, stipulates that every Kenyan has a right to a clean and healthy environment. Article 42(a) requires that the environment be protected for the benefit of present and forthcoming generations through legislative and other measures. Article 43(d) calls for a fresh, safety and adequate water for all.

Article 69(1a) requires that the state shall ensure sustainable exploitation, utilisation, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefit. Article 69(1d) requires the state to encourage public participation in the administration, protection, and conservation of the environment. Article 69(1e) calls for the State to ensure protection of genetic resources and biological diversity. Article 69(1f) requires the state to establish systems of environmental impact assessment, environmental audit and monitoring of the environment. Article 69(1g) calls for the state to eliminate processes and activities that are likely to endanger the environment and Article 69(1h) requires the state to utilise the environment and natural resources for the benefit of the people of Kenya. EMCA (CAP 387) was legislated to provide a suitable legal and institutional structure for the management of environmental matters. It seeks to coordinate the undertakings of the various lead agencies including, Government Ministries, Departments, Parastatals and State Corporation or County authorities in which any law confers functions of management of any component of the environment or natural resources. Several subsidiary legislations have been developed to operationalise EMCA CAP (387).

The subsidiary legislations are; Environmental (Impact Assessment and Audit) Regulations 2003, Environmental Management and Co-ordination (Water Quality)

Regulations 2006, Environmental Management and Co-ordination (Waste Management) Regulations 2006, Environmental Management and Co-ordination (Fossil Fuel Emission Control) Regulation 2006. Environmental Management and Co-ordination (Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit Sharing) Regulations 2006, Environmental Management and Co-ordination (Controlled Substances) Regulations 2007. Other subsidiary legislations are Environmental Management and Coordination (Wetlands, River Banks, Lake Shores and Seashore Management) Regulations 2009, Environmental Management and Co-ordination (Noise and Excessive Vibration Pollution Control) Regulation 2009, Environmental Management and Coordination (Public Complaints Committee) Regulations 2012, Environmental Management and Coordination (Prevention of Pollution in Coastal Zone and other Segments of the Environment) Regulations 2003. See more analysis in section 4.2 of this thesis report.

2.2.5 Petroleum Act 2019

The act provides an integrated legal tool to control the sector. The laws will ensure that oil revenue is impartially shared among the communities, County Government and National Governments using a reasonable share method. In addition, it is anticipated that the Act will propose a clear delineation of roles in policy making for the upstream, midstream, and downstream sectors. See more analysis in section 4.2 of this thesis report.

2.2.6 International Conventions and Multilateral Agreements

Kenya's Constitution, 2010 Article 2(6), stipulates that any treaty or convention ratified by Kenya shall form part of the law of Kenya under the Constitution. The Government of

Kenya has signed several agreements and conventions which if they were to be implemented fully, would lead to a sustainable environmental management (Kirumba, 2014). Discovery of commercial oil in the upstream petroleum sector is a new venture in Kenya and therefore adoption of international standards best practices will go a long way in ensuring sustainable environmental management in the sector (Kigwiru, 2012).

Among the conventions that Kenya is a signatory to includes; the United Nations Framework Convention on Climate Change, the subsequent Kyoto Protocol and the Paris Agreement that regulates on greenhouse gases emissions. Others are the Sustainable Development Goals on Climate Action, Water and Sanitation, Gender Equality, Biodiversity Conservation and SDG on Universal Health.

Other conventions include the Bonn Convention on Protection of Migratory Species by restricting barriers caused by development projects, the International Labor Organisation (ILO), Convention on Indigenous and Tribal People. The ILO acknowledges that indigenous people have a civil liberties to the lands which they customarily occupy, as well as their natural resources even if the government has not recognised that. Such individuals have to partake in the paybacks of developmental projects on their land and they are also entitled to fair compensation in case of any damage.

The Basel convention on the control of transboundary movement of hazardous wastes and their disposal is another international legislation which the Kenyan Government is a signatory to. The regulation requires parties to lessen the amount of harmful waste produced. Moreover it calls for a reduction in the number of transboundary movements of such waste and encourages proper and sustainable management of the environment. These legislations form part of the Kenyan legislations that should ensure sustainable environmental management in the backdrop of oil and gas exploration (Ngare *et al.*, 2016).

2.2.7. International Finance Cooperation Performance Standards on Environmental Sustainability

The international financing groups such as IMF, World Bank Group, and IFC have also set their performance standards on environmental sustainability best practices. Countries and oil and gas exploration companies must comply with the established performance standards pre to the advancement of the developmental loans. According to IFC (2012), the critical performance standards for environmental sustainability by IFC are PS 1 that calls for consideration of social and environmental performance standards from the commissioning to decommissioning of every project. It entails active community participation and involvement by disclosing all information regarding the project openly and transparently. PS1 underscores the need for particular attention in dealing with vulnerable and marginalised communities. The second IFC performance standard that is the PS2 (Labour and Working Conditions) deals with labour and working environments. The rationale of the PS2 is to ensure proper management-worker relationship. It encourages justice among the workers and advocates proper ergonomic management. PS3 (Resource Efficiency and Pollution Prevention) targets are to prevent or reduce pollution from development activities. It explicitly encourages the reduction of emissions that lead to climate change. It also calls for sustainable utilisation of water in case a project requires a significant amount of the resource.

PS4 (Community Health, Safety and Security). This guideline deals with project-related actions such as infrastructure and machinery safety, natural resource and environmental and emergency readiness and response in case of the broader community. It strives to avoid or reduce the dangers resulting from developmental activities. PS4 also covers contagious

diseases linked to the influx of population in search of permanent or short-term jobs. The performance standard also addresses the water ecosystem issues where it requires the provision of fresh water to the communities to protect them from water-borne diseases.

PS5 (Land Acquisition and Involuntary Resettlement) talks about compensation and remunerations for evicted individuals, consultation of community members, a mechanism for handling grievances and resettlement formations and implementation to warrant appropriate displacement of people where required. It strives to shun or reduce uncontrolled resettlement and tries to alleviate negative socio-economic effects from land acquisition. It calls for the appropriate revelation of information, consultation, and full participation of the affected people and the provision of compensation for loss of assets where involuntary resettlement has to occur. Displacement minimisation, compensation paid for lost assets, adequate housing replacement, livelihoods, and standards of living of displaced people restoration.

PS6 (Biodiversity) Conservation and Sustainable Management of Living Natural Resources provides regulation on the prevention of negative effects on biodiversity and ecosystem services. Any dilapidation alleviation should be carried out with the intention of managing renewable natural resources sustainably. PS6 is trying to identify areas of high biodiversity value. The indicator has categorised biodiversity into, natural habitat and these areas have no feasible option, and little loss may arise. The other category is critical habitat and is subject to achieving a net gain of the biodiversity. The purpose of demarcating such environment is to detect areas that would be particularly delicate to the development and to place some stringent measures on developments in this areas. PS6 requires projects in legally protected habitats to fully engage the communities in determining ecosystem services of preference. PS7 (Indigenous Peoples). It avails direction on the avoidance of

adverse effects on the local communities and encourages active communication. It calls for the free prior and informed consent (FPIC) from the communities in areas affected by developmental projects and areas where relocation has to take place from natural resources such as land that has traditional or customary affiliations. The last performance standard is the IFC PS8 (Cultural Heritage). The standard targets to shield unique cultural heritage in-line with internationally accepted practices for its protection, field-based study, and records. According to PS8, important cultural heritage should not be altered and tampered with by the developmental project. Consultation with the affected communities and participation should be involved if need be. Declaring strict compliance and implementation of the local and international regulations among all the stakeholders in the petroleum exploration sector will help in tackling the environmental challenges related to oil and gas exploration activities. The Government of Kenya must enforce the legislations through the relevant lead agencies if sustainable physical, biological and social environmental management is to be realised (Howes *et al.*, 2017).

2.3. Effects of Oil and Gas Exploration on Biophysical Environment

Biophysical environment entails the biological and physical environment. Flora and fauna from the biological environment while water, soils, and air encompass the physical environment (Margaret *et al.*, 1998). Oil and gas exploration involves surveying, clearing of seismic lines, and massive dynamiting for geological excavations (Nnabuenyi, 2013). Other factors affecting the biophysical environment include ground surface and effects interruptions, acquisition of several acres of land for each well pad, brine pits, pipelines, tank batteries and site clearance (Ayuba, 2012). Waste generated from the drilling activities is another major challenge associated with soil and water pollution (Mbithe, 2016).

The study reviewed empirical studies of the effects of oil and gas exploration on biophysical environment from a global perspective and focused on the exploration process effects on;vegetation cover,climate,water and soil resources under the effects of oil and gas exploration on water,soil and climate. The study examined the implication of drilling waste materials on these resource.Majorly the study assessed the drill cuttings impacts and flared gases on borehole water,soil and climate respectively.

2.3.1 Oil and Gas Exploration Effects on Vegetation Cover

According to Ogwu (2011), oil and gas exploration has been noted to cause a lot of changes in the land use of the affected areas.He reveals that there have been intense conflicts of interest caused by the oil and gas exploration activities with the pre-existing land use plans in Niger Delta.Community goals have immensely changed in the sense that the former areas that existed as recreational, educational, religious and grazing lands have been turned into the oil and gas exploration fields(Mogborukor&Phil,2014).

Ogwu(2011),explains that the development of oil and gas facilities alters the nature of the landscape from a rural to a more urbanised setting. He further notes that though such developments had some socio-economic benefits, they caused many deleterious effects on Niger Delta ecosystems. A study done by Mmom & Arokoyu(2010), indicated that the burying of oil and gas pipelines in Niger Delta led to serious disruptions of the Delta fragments rich ecosystems such as rainforests and mangroves.Osei *etal.*(2006),notes that oil and gas exploration activities led to extensive clearing of land cover vegetation as the Well pads and access roads were being put up.Their study focused on assessing the changes in the land size of the Niger Delta forest area between 1985-2005 by use of geospatial data processing and analysis. The study reveals clearly how the ecosystem had

changed due to oil and gas exploration activities. The results did show a slight decline in water bodies from 343,654 to 343,513 hectares, mangrove and closed forest showed a decline from an initial estimate of 55,410 hectares in 1985 to 37,117 hectares and closed forest from 250,161 hectares in 1985 to 175,609 hectares and the Settlement/bare areas increased from 52,738 to 108,725 hectares. Akall (2013) projects that oil and gas development projects in Turkana County would seriously affect the land cover vegetation which the locals depend on for their pastoral and nomadic life.

2.3.2 Oil and Gas Exploration Effects on Water and Soil Resources

Oil and gas exploration activities may result in waste materials that are potential pollutants for water and soil (Namuyondo, 2014). The explosion of dynamite in aquatic environments is believed to have narcotic effects and mortality of fish and other fauna organisms (Olujimi *et al.*, 2011). Destabilisation of sedimentary materials associated with dynamite shooting during seismic surveys is also believed to cause increased water turbidity (Mogborukor & Phil, 2014). The primary source of water resource pollution in the backdrop of oil and gas exploration activities comes from the waste materials generated (Ezekwe *et al.*, 2014). The drilling stage of oil and gas exploration leads to a lot of waste materials generation. According to (Mbithe, 2016) these waste materials entails the drilling fluids contaminated drill cuttings, formation water, spilt drilling fluids and other related waste materials that if not properly managed, may end up polluting the water bodies and the soil.

One of the leading waste materials associated with oil and gas exploration is the contamination by the drilling fluids. The structure of contemporary drilling mud can be quite multifaceted and can vary extensively, not only from one spatial area to another but also from one depth to another for a given well (Shadizadeh & Zoveidavianpoor, 2010). Mbithe

(2016), observes that there are three types of drilling fluids; water-based, oil-based and synthetic-based fluids. Behnamanhar (2014) records that the water-based fluids can be prepared with saline or fresh water and are the ones used in most cases. They are a bit affordable and mostly used in upper sections of well drilling. In case of drilling of water sensitive formations, oil-based fluids form the best choice, also in cases of high temperatures or prevention of drilling bit corrosion (Katarina *etal.*, 2006). Synthetic-based fluids do not have polynuclear aromatic hydrocarbons, they are less toxic, decompose faster, and they bioaccumulate less as compared to the oil-based muds (Neff *etal.*, 2000). The fluids perform various functions during the exploration activities, and key among them is transporting the drill cuttings away from the drill face, lubricating the drill bit and balancing the hydrostatic pressure (Gbedebo, 2010).

Devold (2013) notes that drilling fluids are composed of four components. These are the liquids which could be oil or water-based, the reactive solids which are the density and viscosity part of the system and they are often bentonite clays. The solids which are inert in nature act as a weighting agent to sustain pressure in the well. Additives are used to control the physical, chemical and biological aspects of the drilling fluids. They include the lime and caustic soda to control PH and other conditioning reagents that consist of starches, emulsifiers, lubricants, organic polymers, surfactants, detergents, lignite materials and salts (Mbithe, 2016). Many additives found in the drilling muds are toxic and proper measures need to be put in place in managing them to ensure sustainable management of environment (Eze *etal.*, 2015). According to Kharaka & Dorsey (2005), drilling fluids account for about 4 percent of the total waste generated during the oil drilling activities. Drill cuttings are other waste generated from exploration drilling. According to Neff *etal.* (2000), drill cuttings comprise of minor rock debris formed when the drilling bit cuts

into the rock and extends the hole. These small rock materials are generally uneven with a flake structure and do vary in texture, size and shape depending on the nature of the drill bit and the parent rock material (Balgobin,2012).The formed cuttings are pumped out of the well by the drilling mud running inside the drill string down the drill pipe (Vaughan,2012).Devold (2013) explains that the drilling mud exists via the perforations in the drilling bit and suspends the drill cuttings and is carried to the surface through the annulus and eventually to sediment by gravity in the reserve pit. Drill cuttings account for the most significant percentage of the drilling waste materials, and therefore proper management strategies are very crucial for sustainable environmental management (Onwukwe & Nwakaudu,2012).Produced waters are another form of waste that come with drilling activities.This water is a blend of the naturally occurring saline water in the geologic establishment being drilled, typically resulting in elements such as radionuclides and benzene (Sumi,2005).According to Arthur *etal.*(2005),this water must be removed from the crude oil and gas before their transportation to the pipelines.Produced waters are the primary waste material in the oil and gas production stage.Oily debris, waste chemicals used in the drilling operations and any other material deliberately added to the drilling fluids are all disposed of in the reserve pit (Al-haleem *etal.*,2013).

2.3.2.1 The Harmful Components of the Drilling Waste Material

The most abundant of the harmful elements found in the drilling waste are heavy metals, hydrocarbons and the salts hence their poor disposal on soil or water means contamination to these ecosystems(Al-haleem *etal.*,2013).Mutua(2016) notes that heavy metals in drill waste originate from the naturally occurring formations that get fused into the waste during drilling while others come from additives.The most frequently found selected heavy metals

have customarily been Barium from Barite used as the density control material and Chromium from chrome-lignosulfonate deflocculants (Zoveidavianpoor *et al.*, 2012). According to Odari *et al.*, (2015), Barite comprises of Barium Sulfate (BaSO_4), and it is generally crushed to tiny size symmetrical particles pre its use as a weighting agent in the fluid. Due to the contaminations in the Barites, other metals will also be generally present. Higher levels of Lead, Copper, Nickel, and Zinc in drill waste have been found relative to the commonly occurring metals. Barite has a high level of impurities, considered as the primary source of the mentioned heavy metals contamination in the drilling mud.

Another significant component of the heavy metal pollutants is the Chromium, which is a component of mud additives, principally Chrome-based deflocculants. The hexavalent form of Chromium used as a gel thinner, a stabiliser for high temperature, a biocide and a corrosion inhibitor is quite toxic (Mutua, 2016). Lower concentrations of Arsenic, Cadmium, Mercury, Zinc have been detected in drilling muds (Rourke & Connolly, 2003). According to Conant & Fadem (2012) heavy metals do not stay confined within the waste material generated from the drilling activities but in most cases leach out into the underground water and the soil. The significant distress over their occurrence in an environment arises because they cannot be broken down to non-hazardous forms and so their pollution in any given biome remains a potential permanent threat (Adesodun, 2007). Bassey *et al.* (2013) indicated that the most hazardous heavy metals to both animals and humans health are Lead, Mercury, Cadmium, Arsenic, Copper, Zinc, and Chromium. A study done by Mahurpawar (2015) elucidate that prolonged exposure to Mercury leads to fatigue, weakness, anorexia and gastrointestinal functions disturbances. High exposures can cause spasm and tremors of the fingers, eyelids, lips and even the entire body which may culminate with hallucinations. Exposure to Mercury too leads to nervous system, kidney

and liver damage. Continued exposure to Lead according to the study causes toxic reactions in the neurological, haematological and renal systems, which results in brain damage, convulsions and death. Lead solutions have been documented to be carcinogenic to animals. Exposure to nickel leads to respiratory tract infections and skin allergic reactions and prolonged exposure may lead to cancer cases and neurological breakdowns and eventually death.

He further notes that too much exposure to Cadmium can result in, anaemia, renal failure, pulmonary emphysema, bone fractures, kidney stones, retarded growth, respiratory tract infections, cancer, joints and back pain. Prolonged exposure to Iron leads to cardiovascular diseases and respiratory tract infections. Exposure to hexavalent Chromium leads to severe irritation of the respiratory tract systems, kidney damage, asthma and some cancer cases. Other effects of chronic exposure at high levels include lung cancer and skin infections. Furthermore, the study reveals that prolonged exposure to Arsenic can cause gastrointestinal disturbances, bronchitis, peripheral neuropathy, weakness, skin disorder and damage to the kidney, the liver and the nerves.

Another undesirable constituent of drilling waste at disposal time are the salts (Śliwka *etal.*, 2012). According to Al-haleem *etal.* (2013), the release of waste having higher concentrations of salt in aquatic ecosystems can cause severe damage to the marine life. High levels of Sodium Chloride can tamper with the growth of embryos and fetuses which may lead to fetal death. It can also lead to poor development of the musculoskeletal system and cause eye, skin and upper respiratory system irritation (Bakke *etal.*, 2013). Asche & Lead, (2013) notes that salts can affect plants and vegetation growth by altering the soil pH and other soil chemical and physical structures. Hydrocarbons are other detrimental materials which pose challenges during waste disposal (Onwukwe

&Nwakaudu,2012).Devold (2012) notes that hydrocarbons find their way into the drilling waste through a hydrocarbon-bearing formation or via contamination from oil-based drilling muds.The deeper the well, the higher the levels of hydrocarbon concentration (Balgobin,2012).The different varieties of hydrocarbon groups include the Alkanes, Alkenes and Alkynes,Polyaromatics,Cycloparaffins and Aromatics(Al-haleem *et al.*, 2013).According to Abdel-Shafy &Mansour (2016), prolonged exposure to hydrocarbons lowers the growth rate of animals and the impact of hydrocarbons on human beings is subject to whether the exposure was due to inhalation, dermal contact or ingestion. The short exposure effects of intake may cause mouth, throat, and stomach or even damage to the gastrointestinal tracts. The chronic implications of ingestion may include abnormal heart rhythms,liver,kidney or digestive tract injury. Prolonged exposure to Benzenes may leads to severe blood disorders while extensive exposure to some PAHs may cause cancer of the skin, lung problems, and other sites on the body (Sheehan & McDonagh, 2008).According to Okoro *et al.*(2006), hydrocarbon exposure by inhalation may consist of irritation of the throat, lungs and nose, headaches, and dizziness while for chronic exposure entails muscular weakness, liver and renal damage. A hydrocarbon is known to affect plants by suffocating them air and also interferes with the metabolic process such as photosynthesis,respiration, and transpiration(Rusin *et al.*,2015).

2.3.2.2 Drilling Wastes Disposal

Several methods are used in the management of drilling waste materials. One of these methods is Land farming. Onwukwe & Nwakaudu(2012) notes that land farming encompasses scattering the waste on a chosen area of land and working it into the soil. By spreading the cuttings to the ground the microorganisms such as bacterias and fungi found

in the soil decompose them and feed on them (Śliwka *et al.*,2012).According to Akporfure(2011),this technology calls for a clear understanding of the soil loading capacity to ensure oxygen circulation for the survival of the microbes.

The second method is incineration.It is a form of thermal treatment waste disposal approach. It is very efficient in volume reduction, complete degradation and possible recovery of resources (Bunce,2010).This technology is the one mostly used in Kenya in the management of hazardous waste materials (RoK,2015)

Another technique used in the management of drilling waste material is the Thermal Desorption Unit(TDU).According to Rusu *etal.*,(2013) this technology applies heat either indirectly or directly to the drill cuttings and causes vaporisation of both semi-volatile and volatile organic compounds without incineration of the rock cuttings materials. The study explains that vaporized gases are usually condensed in some thermal desorption technologies while in others they are generally combusted to make the recovery of the hydrocarbons.This approach entails secondary rotating kilns,hot oil processors, thermal distillation, modular thermal processor, thermal phase separation and thermal plasma volatilization(Eze *etal.*,2015).For TDU technology to be effective, its combination with phytoremediation technique of heavy metals is important.Phytoremediation is a technology that uses plants organism and related soil microbes to manage the high levels of heavy metals from the drill cuttings.It is somewhat a current technology and is alleged as economical, effective,original, sustainable, and uses solar technology with good public acceptance.Discovery of new effective metal hyperaccumulators is on-going for applications in this new technology.According to Shevyakova (2011),*Amaranthus sp.* have been discovered to hyperaccumulate Nickel. *Agrostis tenuis* and *Festuca rubra* grass species

have been found to phytostabilize Copper, Zinc and Lead respectively. Sunflower and spinach phytoremediate lead from contaminated water (Raskin & Ensley, 2000).

Vermiculture is another technique used in the management of drill cuttings. This procedure uses worms to putrefy organic waste into a form that can supply nutrients to enhance plant growth and development (Knez, *et al.*, 2006). According to Davis (2016), worms do improve quick decomposition of hydrocarbon-based drilling muds. The degraded materials form organic farming manure. This technology is an alternative drill cuttings management approach since it is eco-friendly (Sinha, *et al.*, 2010).

The other management method for drill cuttings is solidification. According to Alansary (2007) solidification is a cost-effective process that can be applied to solidify pit fluids immediately after well completion. Solidification comprises of the removal of the free liquid portion of reserve pit solutions and then adding solidifiers such as fly ash, lime kiln dust or cement (Opete *et al.*, 2010). Other management approaches include the down-hole injection of drilling fluids. According to Veil & Dusseault (2003), oil companies in Alaska do inject the cuttings generated from oil and gas explorations and drilling activities underground after they are finely grounded and assorted with a liquid to form a slurry. The technique is usually used together with pitless drilling. Slurry injection of the waste materials has a less environmental impact as the waste is disposed of deep into the ground (Ifeadi, 2004). Reserve pits are usually used in the management of drill waste materials especially drill cuttings. Reserve pits are generally closed following a well completion and liquids in the pits may be evaporated, discharged to land or surface waters, re-injected in underground wells, or trucked off-site for disposal (Ramirez, 2009). Reserve pits will, however, continue to be the principal method of drilling waste storage and management (Nagy, 2002). According to Sumi (2005) regulations for siting, operation and

closure of pits, the proper closure of reserve pits and the disposition of their contents is still a matter of concern in the environment. Poor management of reserve pits may cause the leaching out of contaminants in drill wastes through pit sides and may contaminate soils, vegetations and groundwater aquifers (Mbithe, 2016). Ramirez (2009) notes that rainfall and flooding may also carry these contaminants into the nearby soils and surface waters. In some instances, the pits berms may rupture and overspill of pit contents causing water and soil pollution. Even where the reserve pits are lined, at times the liners may get torn leading to recurrent leaks. According to Bakke *et al.* (2013) leaching of pollutants has also been experienced in areas with permeable soils even after pit closure. Wildlife has been reported to die after contamination from the reserve pits. Cases of birds dying have been reported in the US (Sumi, 2004). For there to be sustainable environmental management around the oil fields, proper management of the generated waste materials needs to be carried out. Treatment of drill cuttings before they are disposed of is necessary and analysing them to determine the levels of pollutants is critical (Ramirez, 2009).

2.3.3 Oil and Gas Exploration Effects on Climate Variability

According to Hamilton (1998), oil and gas exploration activities have been noted to contribute immensely to atmospheric pollution. He indicates that burning of natural gas is a technology used to dispose of associated gas with crude oil. Gas flaring among other factors has been documented to cause climate change and variability. Atmospheric temperatures have been on the rise due to increased greenhouse gases emissions with fossil fuel contributing a big junk of the gases (Ahmed, 2017). In December 2015, 195 nations convened in Paris France for the United Nations Framework Convention on Climate Change, conference of parties (COP 21). According to this convention, a goal was set to

keep the 20th century's global average temperature increase to less than 2⁰ Celsius above the pre-industrial levels of the period between 1850-1900. The agreement in addition outlines a more firm aim of limiting temperature rise to only 1.5 degrees Celsius above pre-industrial era levels. The agreement called for zero net anthropogenic greenhouse gases mostly from oil and gas sector, by the second half of the 21st century (Erbach, 2016).

Gas flaring which is the primary source of emissions is defined by Gervet (2007) as the measured combustion of natural gas. He further explains that a flaring structure consists of a flare stack and pipes that supplies gas to the stack. He explains that flares produce noise and heat and the noise could be very intense depending on the speed of the gas passing through the flare stack. It is necessary to flare the gas despite its high economic value during drilling, production and processing.

Emam (2015) reports that in drilling a well, flaring is very critical in testing well production since it helps in determining flow and composition of the oil and also the pressure of the well. He further notes that the flaring can last for some days or weeks until the flow of the liquid stabilises. Gas flaring is a major causative factor to global warming and increased levels of Sulphure dioxide (SO₂), Carbon monoxide (CO) and Nitrogen dioxide (NO₂), Hydrocarbon ash, particulate matter, Hydrogen Sulphides (HS) and photochemical oxidants such as smog and tropospheric ozone. According to Cline (2008), the pollutants above causes changes in the pH of the soil and the water ecosystems and also depletes soil nutrient and may lead to the absence of vegetation around the areas with acidic soils. In addition to the negative implication in the field of agriculture, there are several adversative effects on animals and human such as haematological effects as noted by Ismail (2012).

He further notes that the flared contaminants in the air cause adverse health effects in human, including, respiratory tract infections, lung damage, cancer, reproduction and neurological effects. Opong (2010) notes that pollution from oil and gas exploration activities causes deformities in children, eye infections, and skin problems. He further indicates that hydrocarbon composites have been observed to cause some adversarial alterations in haematological parameters. These alterations affect blood-producing cells and may end up resulting in Anaemia mostly Pancytopenia and Leukemia. Turkana County experiences hot and dry climate with food and water being scarce resources (Opiyo *et al.*, 2015). Increased temperatures and acid rain in the area due to the emission of the pollutant gases will worsen the conditions, and the pastoral livelihoods of the locals shall be adversely affected.

2.3.3.1 Sustainable Gas Flaring in the World

The World Bank group has initiated a ‘Zero Routine Flaring by 2030’. The initiative brought together governments, development institutions such as IFC, Asian Development Bank, OPEC Fund for International Development, East African Development Bank and African Development Bank. Other bodies include the inter-American Development Bank, Agence Française de Development, Islamic Development Bank, United Nations Sustainable Energy for all, ECOWAS Bank for Investment and Development, West African Development Bank, European Bank for Reconstruction and Development and the oil companies (WBG, 2015)

According to the initiative, the parties agreed to eradicate routine flaring by the year 2030. The initiative pertains to routine flaring and not to flaring for security motives or non-routine flaring. Governments that sign the Initiative are expected to develop a legal,

monitoring, venture, and functioning environment that is favourable to oil and gas exploration and production ventures and to the expansion of sustainable markets for consumption of the gas and the infrastructure necessary to convey the gas to these markets. The reports note that by monitoring vital factors, such as composition, heating values, gas stream flow rates and, process unit performance, gas flow rate, and pilot flare presence will help facilities to identify, respond and correct most flaring activities. The initiative will offer companies the assurance and incentive as a foundation for capitalising on flare eradication solutions. In addition, governments are required to specify in their new prospect offers, the field development plans for new oil fields and incorporate viable utilisation or conservation of the field's related gases minus routine flaring.

Moreover, the governments will endeavour to ensure that routine flaring in the existing oil fields ends as soon as possible, and not later than 2030. Oil companies that ratified the initiative are required to advance new oil fields that they operate with plans that integrate sustainable consumption or preservation of the field's associated gas without routine flaring. Furthermore, the oil companies with routine flaring were to implement economically feasible solutions to eradicate this legacy flaring as soon as possible, and no later than 2030. The initiative also demands for the development of the institutions that support the initiative to expedite collaboration and enactment and deliberate the use of financial tools and other methods, principally in their client countries. They were required to do so even in countries that are not signatories to the initiative.

The oil companies and governments that approve the initiative are required to openly report their flaring and development towards the initiative on a yearly basis. They also agreed that the World Bank would be combining and publishing the same reports annually. Norway was the first government to support this World Bank initiative. The country has been using

the flare gas recovery technology over the years such as flare jet. According to Smith & Seefeldt (2013), the technology minimises gas flaring and the recovered one is utilized for economic benefits within. The country introduced Carbon dioxide emission tax, and this has coerced the exploring companies to lessen the amount of the gases they flare.

2.4 Effects of Oil and Gas Exploration on Socio-economic Characteristics

Oil and gas exploration activities have numerous effects on people's socio-economic characteristics (Kadafa & Ayuba, 2012). The effects according to Rourke & Connolly (2003) can either be positive or negative. The study focused on both positive and negative effects from other jurisdictions as explained below.

The positive effects include the development of social amenities in the areas around the oil fields such as schools, hospitals, boreholes and water connectivity. Other positives include, employment in the oil companies, the connection of the electricity, urban area expansion, and business growth, road constructions and many more which form parts of the Oil Company's corporate social responsibilities. However, many times these positive effects, generally if sustainable measures are not put in place to manage them, they end up not benefiting the local communities, or they may cause more harm through the indirect negative effects.

According to Nunziata & Nunziata (2014), urban expansion due to job and business opportunities leads to population influx which may result to insecurity issues such as crime, inadequate waste disposal and management, and moral decay. Population mobility that leads to boomtown due to expanded urban areas and job availability acts as a significant driver of the HIV endemic. It has been identified to introduce riskier sexual behaviors (Dean, 2013). The direct negative implications include land and water pollution that may

affect people's livelihoods and health, conflicts, increased cases of school dropouts due to immediate semi-skilled job opportunities, interruption of animal migration routes among others (Ayuba, 2012). In this section the study examined the effects of oil and gas exploration on urban growth. They include, spread of HIV new cases, population influx, livelihoods, land displacement, establishment of social and physical infrastructures, livestock migration routes, and a number of socio-environmental conflicts cases in other jurisdictions.

Oil and gas exploration led to a boomtown, and increase of crime cases in Alberta in Canada (Ruddel 2009). The HIV/AIDS did spread due to population influx in search of job opportunities. Erosion of the locals' culture, alteration in livelihoods sources, increased stress due to noise and water pollution were the significant social challenges documented in Taranaki in New Zealand when the country ventured in oil and gas exploration in the area (Greer, 2013).

The case of Niger Delta gives another good picture of oil and gas exploration effects on people's economic and social well-being. Many communities in Niger Delta were dependent on land and water resources for their livelihoods through agriculture, pastoralism, and fishing (Kadafa & Ayuba, 2012). Although there were some positive effects such as improvement of social amenities, the cutting down of trees during oil seismic surveys and construction of roads and pollution of water bodies by the oil-exploring companies affected people's livelihoods immensely (Julius *et al.*, 2011). Many people abandoned their traditional sources of livelihoods with many young people seeking employment in oil companies which were remunerating them very poorly hence the unsustainable source of livelihoods (Odularu, 2008)

Another excellent example of how oil and gas exploration can negatively impact people's socio-economic aspect is that of West Kordofan state in Sudan. The economy of West Kordofan State was predominantly dependent on agricultural production consisting of rainfed cultivation and traditional livestock practised by nomadic and semi-nomadic agro-pastoral and sedentary groups (Chavunduka & Bromley, 2011). Fallet (2010) notes that the communities' lives began to change as a result of oil and gas exploration activities which affected their livelihoods pattern economically, socially and environmentally. He notes that despite the vast deposits of the oil resource in the area, the locals are lagging behind and suffering from the lack of essential social and physical infrastructures such as health, education and clean water, with perpetual civil wars and conflicts over the resources.

According to Chavunduka & Bromley (2011), the oil companies and the concerned ministry did not take enough measures to build the capacities of the local communities and to integrate them to guarantee smooth and sustainable development. They further reveal that the oil and gas exploration activities in Kordofan region affected animal migration routes since the communities are mostly sedentary and nomadic pastoralist, the cultural heritage of the people was affected by the oil and gas exploration activities.

Another challenge linked with oil and gas exploration activities in Kordofan area in Southern Sudan as noted by Fallet (2010) is the challenge of conflicts over the degraded resources due to oil and gas exploration activities or conflicts over opportunities that come with oil resources. Worldwide social cohesion has been a challenge in areas thought to have oil resources (Klare & Zellen, 2013). Oil companies working in the Niger Delta have played a significant role in the disintegration of values and systems in the area. The disintegration got achieved through an unpleasant reshaping of the local political landscape

and the introduction of fraudulent and divisive community relation policies significant to the divide and rule strategy of colonial Nigeria (Babatunde, 2010)

A study done by Simbine (2008), indicates that oil-related activities such as exploration bring about the politics of oil and this has fueled oil associated conflicts in the oil-bearing areas. These conflicts have different forms. They can be conflicts within a community, the conflict between host communities and the oil companies and conflict between communities.

According to Osaghae *et al.* (2005) the inter and intra communal conflicts are usually oil-induced as depicted in Nigeria where the presence of oil has worsened political disputes over territory or other rights. Since the discovery of oils in the 1950s in Niger Delta, the conflicts between the Ugbo and Mahin-ilaje have intensified and oil mostly fuels them. Other documented cases of conflicts are the bloody conflict of 1998 between the Arogo-ijaw and the Ugbo-Ilaje, which resulted from the discovery of oil in a boundary town between the two ethnic groups (Akanji, 2012). Even though the oil industry is held responsible for a variety of harms and for not doing enough for the areas where they function, communities are also aware of the potential profit of having oil pipelines pass through their land for there are opportunities for compensation payments and contracts, even if the compensation only reaches a few. Therefore, disputes between communities, which may have been latent can be stirred up by the proposal of an oil pipeline installation as well as damage caused by oil pollution (Namuyondo, 2014)

A study conducted by Oyefusi (2007) revealed the issue of divide and rule tactics of oil companies used in Niger Delta. The study that mainly adopted focus group discussion model of data collection indicated that the oil and gas exploration companies were using the award of contracts to intentionally divide communities and thus control them without

a serious challenge to their operation. The study also revealed that politics of oil in the study areas involves only a few elite, segments of these communities. These class of people profits immensely from the oil companies and the wealth they amass and use to control the political deeds of the larger majority. Akujuru(2014) exposes that the elite class in most cases would under negotiate on behalf of the community, without their knowledge, for instance, if the community is entitled to \$10 million as compensation, they may collect \$2 million instead.

According to Osuoka(2007), the government officials of the Federal Government of Nigeria were also culpable of the above malpractice. He further explains that oil and gas exploration ill-related activities had increased the people's level of involvement in local politics. The elites are mostly politicians, being a member of their parties implies that the benefit accruing to them from oil activities will trickle down to their supporters. As such, active participation in party politics, as field observation revealed, is a major factor determining whether a person would benefit from the loots of oil given to the elite. There is therefore a clear financial incentive to political activities, which has negatively influenced on the attitude of the youth towards productive enterprises, particularly about fishing and other traditional economic ventures (Scoones, 2009).

Sudan depicted a similar scenario since the oil discovery in the late 1970's. The political and economic situation conflicts in the country has always been aggravated by the oil resource (Klare, 2012). The oil discoveries played a fundamental role in igniting the second civil war in 1983 and convoluted the possibilities for peace between the Southern and Northern part of the country as it became the central objective for the warring parties. Even after the separation of the two countries, i.e., Sudan and Southern Sudan in 2010, conflicts have persisted in Southern Sudan over the control of oil resource (Klare &

Zellen,2014).The discovery of oil in Kenya in 2012 has already started fuelling some conflicts.From the year 2014, for example, the transboundary and inter-clan conflicts cases have been intensifying especially between the boundaries of Lorogon, Nakwamoru, Napeitom, Juluk, Kainuk and Kalingorock villages, as communities fight for the land resources supposed to hold oil deposit(Schilling *etal.*,2015).Oil and gas exploration operations had to be suspended in late 2013, in Turkana East and Turkana South Sub-Counties following demonstrations by the local communities.Among other grievances raised were, lack of compensation of community grazing areas, side-lining of the locals in employment opportunities and obliteration of the environment by the oil companies(Johannes *et al.*,2017).

2.5 Theoretical Framework

This study was based on five major theories namely; the Political Ecology, Institutional, Sustainable Livelihood,the Tragedy of Commons and Environmental Scarcity theory.The theories were all adopted into this study to complement each other in areas where there are lacuna that would enhance the realisation of a sustainable environmental management approach against the backdrop of oil and gas exploration in South Lokichar Basin,Turkana County.The concept of sustainable environmental management tackles the principle of needs and societal equity(Morelli,2011).Sustainable environmental management will usher in the concept of environmental sustainability(Lin,2009).The concept has three pillars, that is, environmental, economic and social aspects(Basiago, 1999).Sustainable environmental management in the context of oil and gas exploration in Oil Block 13T South Lokichar Basin means that the biophysical and social environment should be managed in such a way that the present generation should be able to meet their own needs as well as permit the

future generation to inherit resources that are in good condition so that they can also benefit from them. The concept of sustainable environmental management may be an elusive mirage if poor management practices of oil and gas explorations fields are practised (Howes *et al.*, 2017)

2.5.1 The Political Ecology Theory

Various scholars define the concept of Political ecology differently. People face unusual ecological circumstances when they have too much or too little resources exposing them to high risks of violent conflicts (LeBillon, 2001). The phrase "political ecology" was developed and published for the first time as an article in 1935 by Frank Thone. Since then it has been extensively used in the perspective of human ecology and human geography (Khan, 2013).

According to Quandt (2016), political ecology is the study of the links between political, social and economic dynamics with environmental factors and changes. Political ecology politicises environmental issues and other phenomena. Resource scarcities mostly for non-renewable resources such as oil and resource abundance (concerning non-renewable resources) all generate conflicts and in most cases, these conflicts are politically triggered. According to Bixler *et al.* (2015) previous approaches to political ecology embodied insufficient steps whose focus was to separate environmental issues and politics in the environmental plan. The approach did not only cause problems that led to environmental strategies to put unnecessary restrictions on livelihoods of marginalised people, but it also provoked conflicts.

According to Robbins (2012), issues such as poor relations and engagement in conservation and development plans, inequality and poverty of the affected communities are time and

again overlooked yet they relate more to processes of nature conservation and degradation. The theory is adopted in this study as it depicts how pastoral communities in South Lokichar who depend on environmental resources such as dry forest vegetation, community grazing land, and water resources can be affected by decisions made and actions taken by the people in power over discovered oil resources without their full participation and engagement. Worldwide political leaders and government agencies with vested economic interest have been compromised by oil exploring companies through kickbacks at the expense of the local communities (Akanji, 2012). He notes that political leaders have also been observed to marshal the locals to protest against the oil exploring company and the government from drilling or transportation of oil resources whenever their economic expectations are not met.

The demonstrations by the locals oblivious of the sycophancy nature of their political leaders have always halted the operations of the oil exploring companies including land restoration and waste management. Illegal licensing on the waste disposal and management of the oil exploring companies by the government agencies have always resulted to environmental pollution. Political ecology theory has been experienced in Niger Delta oil and gas exploration and environmental management processes. According to Nwankwo (2015) the local political leaders heavily contributed to the environmental degradation that immensely led to the loss of livelihoods in the basin. He notes that companies would corrupt the political class at the expense of the local communities' justice for compensation over their polluted agricultural land, degraded mangrove forest ecosystem and water resource. The degradation cascaded into conflicts between the local communities, the oil companies, and the Federal Government since the locals could not receive fair compensation as the oil companies collaborated with the elite political class at

their expense. A related scenario got reported in a study done by Fallet (2010) in Southern Sudan, where the contest of political power controls of the oil-rich region led to conflicts and environmental degradation. The stance for political ecology theory is to draw attention on the essence of integrating all categories of the locals and environment as any division may be a starting point of oppressive policies based on coercive conservation (Kepe *et al.*, 2008). The findings of this study will inform the governing institutions at the National and County Government levels about the diverse complexities that surround the environment, the people and development issues around the oil resource to enhance sustainable environmental management concept. Effective management of resources like oil and gas take in functions played by institutions of governance in establishing various measures including transparency, locals' engagement and consultation which aim at sustainability (Genus, 2014).

Institutions are viewed as guardians for future generational rights that should enforce sanctions to ensure generational rights are preserved (Padilla, 2002). The aspect of devolved government in the Kenyan setup, multiparty democracy and the devolution of the Ministry of the Environment while the oil mineral resource remains a resource of the state calls for proper coordination of all the agencies for there to be sustainable management of both social and biophysical environment in Turkana. Section 2.5.2 examines in details the role of institutions in the realisation of aforementioned sustainable environmental management concept.

2.5.2 The Institutional Theory

Institutions are 'social' structures which have attained a high degree of resilience (Scott, 2008). The origin of Institutional theory can be credited to the seminal work of Berger and

LucKmann of 1966, who records that institutions are centres for social interactions and they do control social actions.Meyer and Rowan developed this into the new institutional theory in 1977 with a more elaborate definition. They argued that, in modern societies, organisations are in highly institutionalised settings of numerous professions, policies and programs, which serve as powerful traditions.The institutional theory has three facets; the regulative,cultural-cognitive and normative aspects. According to Palthe (2014), these three aspects cannot be separated and when combined with appropriate activities and resources they bring about stability and meaning to social life. She further notes that institutions operate at various degrees of power ranging from ,international, regional ,national ,county and community levels and are affected by both periodic and constant change which could be as a result of changing political dynamics. Scott (2008), explicate that institutions have the capacity to control and refrain behaviour thus being able to manage actions which agrees with the work of the developers of the institutional theory aforementioned. He further notes that they control decision-making aspect over various issues affecting people, communities or environment.Institutions are put together by structured activities determined by perpetual behaviour or practice (Bixler *et al.*2015). Palthe (2014), records that institutions can enforce restrictions through legal, moral and cultural limits in ensuring legitimate from illegitimate actions.

The approach explained by Palthe(2014),clearly defines the process through which Kenyan institutions have been built. The normative,regulative and cultural cognitive pillar represent the underlying methods applied in constructing change influencing planning and organisation outcomes to try to avert conflicts and overlapping roles in the oil industry.According to Henisz & Levitt (2011),the regulative pillar of institution theory entails social law and order.It deals with instituting mandatory rules for observation, and

in the context of this study, these may include developing and enforcement of legislations and policies on proper drill waste management, emissions, pollution controls, sustainable oil drilling processes, land restoration, compensation and sharing of revenues from the oil resource. They further note that the normative pillar puts focus on desirable goals by emphasising on, how things are done while the cognitive component has its basis on how institutions make individuals and other actors conform to behaviour about conventional ideas of social realism. Institutional theory is used in this study to have a complete understanding of how institutions can drive players that is the National Government, the County Government and various lead agencies, the oil companies and local communities to have coherence in governing actions. This coherence can occur if policies and legislations on land restoration, sustainable drilling process, air pollution, land compensation, revenue sharing, public participation and consultation, waste management and conflict resolution are developed and enforced by the relevant agencies.

According to Alayli & Karp (2005), nations with weak institutions are liable to experiencing poor resource management. They argue that these governments cannot be held accountable for the control of resources and corruption that takes preeminence across the various sectors. Biermann *etal.* (2012) argues that existing organisations and their activities can significantly affect chances for poor people accessing and benefiting from assets, which consequently impact livelihood strategies. They also explain that well-established institutions are fundamental in influencing developmental outcomes and assessing conflict risks as well as preventing the miss-use of resources.

According to Mähler (2010), Niger Delta oil and gas exploration fields in Nigeria is considered as a place of social and environmental conflict due to existent of weak institutions with no developed framework to constrain behaviour subsisted before oil

extraction activities. Several empirical studies done in oil rich fields by Obabori (2009), Ekpu (2009), Ojealoro (2009) and Nakagami (1995) mostly focused on a regulative pillar of institutional theory with emphasis on the biophysical environment with little attention to socio-economic sustainability. IFC (2017) publication on environmental sustainability model points out that empowerment of individual's marginalised groups on the essence of diversification on sources of livelihoods and stronger social institutions is now a prerequisite before oil and gas exploration activities commence which shows how significant institutions are in resource explorations. The model, however, does not examine the structures and the systems that should be put in place to ensure, that the pressures put up by the institutions does not scare away the investors who are doing the exploration and changing the socio-economic characteristics of the local communities. The model still does not weigh in, to ensure that the systems proposed are not weak enough for the local communities not to be compensated for acts such as displacement, environmental pollution, not to secure employment with the exploring firms, while still safeguarding the ecosystems.

This study adopted Sustainable Livelihood Approach (SLA) to integrate all these components that is, the biological, the physical and the socio-economic environmental aspects. The Sustainable Livelihoods theory harmonises the Institution theory by drawing attention to the essential role played by institutions, which establishes how people can access diverse forms of incomes and utilise them in advancing sustainable livelihoods while their natural resources are being used sustainably (Nyamwanza, 2012). The approach is critical, bearing in mind that oil and gas exploration is a new venture in Kenya, and pastoralism is the primary economic activity in the area of study. Development and implementation therefore of regulations on land restoration, compensation, water resource

management from pollution, community engagement, and local content is essential. At the same time capacity building needs to be done to the local communities to ensure sustainable coexistence with the investors and the oil and gas exploration companies. A balance should be struck not to oppress and scare away investors through accommodative regulations, and this necessitated the integration of the aforementioned sustainable livelihood approach outlined in section 2.5.3 below.

2.5.3 Sustainable Livelihood Theory

The Brundtland Commission first presented the sustainable livelihood concept in the World Commission on Environment and Development report of 1986. The 1992 United Nations Conference on Environment and Development extended the idea, encouraging for the implementation of sustainable livelihoods as an overall goal for poverty extermination (Krantz, 2001). Knutsson (2006), notes that sustainable livelihood framework is the capabilities, assets (including social resources and materials) and activities required for a means of living. In addition, he says that livelihood is sustainable when it can cope with and recover from shocks and stresses and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base. According to Morse *et al.* (2009), the assets in this theory represent the fundamental building blocks which include social education and health support. Their vulnerability context which include limited resources such as water and grazing areas and security issues govern people's access to their assets. Several frameworks have been developed on sustainable livelihoods and this study adopted the now DFID universally acceptable sustainable livelihood framework shown in Figure 2.2 below. DFID (2008) notes sustainable livelihood framework has been divided into three parts: the asset portfolio which represents the

nucleus of livelihood, the vulnerability context and policy, institutions and processes and the loop connecting livelihood strategies and livelihood outcomes.

The sustainable livelihood approach combines very well with the theme for the study, as it clearly demonstrates how different oil associated activities such as land displacement, degradation of dry forest vegetation may have an effect on specific livelihoods supporting activities such as pastoralism and small-scale farming and other social and physical infrastructures within the oil production fields.



Tendency of the locals abandoning their indigenous sources of livelihood for employment in the oil sector is very high. The question on the sustainability of the locals livelihoods should always arise bearing in mind that jobs and employment in the oil sector is cyclic (Gyagri *etal.*, 2017). Oil and gas exploration through cooperate social responsibility from the investors has led to development of road infrastructures, water provisions, urban centres boom, establishment of social amenities such as hospitals, schools and scholarships (Lauwo *etal.* 2016). However these researchers did not examine the sustainability concepts of the developments that initially comes with such kind of ventures, an issue that this study examined under the concept of sustainable livelihood approach. Poor policies on capacity building to the local communities and investors on the essence of diversification to different sources of livelihoods may lead to serious economic crisis. According to Johannes, *etal.* (2017) following Kenya's new venture in oil and gas exploration industry a number of challenges concerning community livelihoods have been experienced ranging from the influx of new people in Oil Block 13T South Lokichar

Basin oil fields, increased prices of commodities, land displacement and limited grazing lands and this has contributed to struggle and conflict for compensation over land resources eroding the peaceful social coexistence among the locals. They further noted that 80 percent of the locals in Oil Block 13T South Lokichar Basin are dissatisfied with the on-going oil and gas exploration activities in the area. If people earn their livelihoods from environmental resources, then any poor administration of these resource has a direct effect on people themselves who may not have the alternatives (FAO, 2008).

The sustainable Livelihoods approach offers a set of vital normative principles that guide actions to address community complexities and these include; people participatory approach and engagement, empowerment and sustainability in utilisation of resources and structures (Morse *et al.*, 2009). Carney (2003) states that Sustainable livelihood approach is people-centered, the centre of attention should be on poor people's livelihood other than the resources, or services they may use. It should bring about empowerment, which accords a voice to the needs and welfare of the people. She also notes that sustainable livelihood approach should also be responsive and participatory which should induce active participation of people to locate and tackle their issue. Finally, she indicates that it should be sustainable by harmonising economic, institutional, social and environmental sustainability as dimensions to sustainability. The outcome above is the agenda that this study is seeking to advance among the communities living in the oil field for it will ensure sustainable environmental management in the backdrop of oil and gas exploration. Proper measures need to be put in place in the extractive oil sector in Kenya that will strike a balance between oil and gas exploration developments, ecology, and the locals' livelihoods management. The knowledge on the tragedy of commons theory discussed in section 2.5.4

below in oil and gas exploration sector is very critical in this study because lack of balance on the environmental resources extraction may lead to serious tragedies.

2.5.4 The Tragedy of Commons Theory

The concept of the tragedy of commons originates from an essay done in 1833 by the Victorian economist, William Forster Lloyd. Lloyd used a hypothetical example of the implications of unfettered grazing on common land, and then referred as 'Commons' in the British Islands. The model became extensively famous over 100 years later due to an article published by the ecologist Garrett Hardin in 1968. In the article, the commons are taken to depict all shared and uncontrolled resources such as oceans, atmosphere, rivers, fish stocks, communal land, roads, and so on. In the context of the oil sector, Agbonifo (2015) looks at it from the point of independent oil sector due to corruptions by the agencies who should implement regulations to control pollutions from gas flaring, drill waste materials management, regulations to ensure land restoration and compensation to the displaced local individuals. He outlines that, the continued failure can easily describe the theory by the regulatory agencies in Nigeria responsible for ensuring that oil companies follow best practices in exploring and producing oil resources. He further notes that many times the institutions responsible for environmental auditing and licensing gets compromised, and this has always resulted in tragic repercussions for the entire Niger Delta community.

Ayub (2012), records that despite the enormous profits by these oil companies many Nigerians in this region have continued to live on less than one dollar per day. He further notes that there has been a total impoverishment for local inhabitants who have traditionally depended on fishing and agriculture. He also attributes this to the environmental degradation brought about by the oil companies in the area that has always supported close

to 20 million Nigerians. Oil and gas exploration activities in the region has led to health problems with cases such as respiratory tract infections, eye irritations, skin rashes, cancer and gastrointestinal infections perpetually being on the rise due to water, soil and air pollution (Ana,2011).

Turkana County in Kenya, where this study was carried out, is inhabited by marginalised communities. Pastoralism being their primary economic activity, environmental degradation and water pollution due to exploration activities and poor compensation by the government and the oil companies could cause suffering to the entire community with issues such as diseases, water shortage, loss of income, water and air pollution, interference with livestock migration routes arising (Schilling *et al.*,2015).The researchers point out that the reason is that the area has scanty of water and grazing pasture resources and degradation on them with poor regulation on sustainable management may push the local communities out of the vicinity.Narengo(2011) records that exacerbating the problem of limited resources in the area may intensify the inter-clan or inter-community conflicts aggravating the constant issues.This aspect of environmental degradation on scarce environmental resources leading to disputes and peace instability,consistent with Homer-Dixon (2010),Environmental Scarcity theory work as discussed in section 2.5.5.The adoption of the theory was to help in comprehension of the happenings in Turkana County endowed with limited environmental resources.

2.5.5 Environmental Scarcity Theory

Thomas Homer-Dixon is known to be the father of Environmental scarcity theory, developed in the year 1996. According to Homer-Dixon (2010) , environmental scarcity could yield violent conflicts. He further explains that the leading cause of such disputes

ranges from local environmental degradation to ethnic clashes, to civil strife (insurgencies), scarcity induced wars out of a loss of sources of livelihoods and the negligent behaviour of the state and elite class. Scarcity is believed to be rapidly spreading in many marginalised land environments, owing to ongoing processes of environmental degradation caused by the ever-growing population size (Aydogan, 2015). According to Homer-Dixon (2010), Environmental scarcity theory has three primary domains. These are demand-related scarcity, structural scarcity and supply-induced scarcity. He explains that demand-related scarcity arises out of population growth as against to its source of livelihoods. Supply induced scarcity emerges when resources rate of depletion exceeds the rate of regeneration. Structural scarcity occurs due to the inequitable distribution of resources. The intervening variable between environmental scarcity and civil conflict is inequality. Such inequality eventually leads to civil strife (Mwaniki, 2010)

Bernauer *et al.* (2011) notes that increased environmental scarcity caused by one or more of these factors is perceived to have more repercussions, which in turn may yield domestic armed conflict, with intervening variables such as reduced economic activity, decimated agricultural production, migration and a weakened state helping to build up the environmental scarcity and violent conflict. They further note that as people's quality of life changes due to reduced environmental resources such as water, grazing land, and the aspect of competition may ensue over the scarce resources; such competition if unchecked could turn fierce and may result into violent conflict. According to Galvani *et al.*, (2016), ecological balance is linked directly to environmental degradation, leading to structural violence. Environmental scarcity in Oil Block 13T South Lokichar Basin oil fields shows how oil resource exploration activities may trigger lack of critical ecological resources mostly grazing land, farming land, and waters resources. According to Homer-Dixon

(2010), environmental scarcity results into severe social stresses within countries, helping to stimulate ethnic clashes and urban unrest. This assumption supports the study to demonstrate how and why communities around the oil fields which depend mainly on these environmental resources such as dry forest vegetation and other forms of grazing pastures, water resources and farming land fight to control the left-over waters, grazing areas, and farming land. Unequal distribution of resources such as, compensation for the environmental damage or, payment for the community land can also result to structural scarcity leading to civil insurgency. He further notes that environmental degradation is undoubtedly not a necessary condition for armed conflicts as it describes the supply-induced scarcity. States do play a key role in containing or aggravating violence as noted in section 2.5.4.

The significant causes of the tragedy of commons is a failure by state agencies to implement policies and legislation due to corruption, hence, structural induced scarcity, Homer-Dixon (2010). In line with his explanation, for sustainable environmental management approach to be achieved in Turkana County demand induced environmental scarcity and structural induced scarcity must be addressed. Demand-induced scarcity management entails land restoration in areas where exploration has taken place, proper management of waste materials to avoid water and air pollution. Structural, environmental scarcity could be managed by ensuring, adequate legislation and policies on environmental management are developed and implemented by the relevant lead agencies and stakeholders.

Table 2.1: Theoretical and Conceptual Framework Relationships (Source: Author, 2017)

Theoretical framework	Conceptual framework as packaged in the objective
Political ecology theory	Effects of oil and gas exploration on biophysical environment(land,vegetation,air,water,conflicts,local content)
Institutional theory	Legal, policy and institutional framework on oil and environmental management in Kenya(policies,legislations,drilling processes, governments and agencies)
Sustainable livelihood theory	Effects of oil and gas exploration on socio-economic and bio-physical environment(corruption, population influx,pollution,livelihoods,employment,compensation,public participation, land displacement, conflicts)
Tragedy of commons	Legal, policy and institutional framework, oil and gas exploration effects on socio-economic and biophysical environment(lack of
Environmental scarcity theory	enforcement of law, corrupt institutions,pollution,population influx Oil and gas exploration effects on bio-physical environment(vegetation,land,water resources)

2.6 Conceptual Framework on Oil and Gas Exploration and Sustainable

Environmental Management in Oil Block 13T South Lokichar Basin

The conceptual framework below was based on sustainable livelihood theory, the institutional approach, political ecology theory, tragedy of commons and the environmental scarcity theory with emphasises on natural resource management. The study considers the natural capital in the context of this study, the land,oil resource, water resource and the vegetation as per sustainable livelihood framework approach, to be the independent variables which are packaged in the effects of oil and gas exploration on biophysical environment objective. Proper oil and gas exploration process packaged in the legal, policy

and institutional framework objective will lead to sustainable management of other natural resources such as land, water, air flora and fauna. The sustainable socio-economic aspects captured in the effects of oil and gas exploration on socio-economic characteristics of the locals in Turkana County will depend on the sustainability of land, water, flora and fauna (Akall, 2013). Good institutions of governance, regulatory and policy framework will result in sustainable environmental management as informed by institutional theory. The institutional theory can enforce restrictions through legal, moral and cultural limits ensuring legitimate from illegitimate actions (Scott, 2008).

A weak institution with no developed framework to manage oil and gas exploration activities has been the primary cause of the Niger Delta environmental degradation (Alayli & Karp, 2005). Poor regulations and policies more often than not are politically influenced. This is informed by the political ecology theory which was coined by Frank Thone in 1935 and seeks to appreciate the complex interrelationship between nature and society through observant examination on means of access and control over resources and their effects on sustainable livelihoods and environmental welfare (Forsyth 2008). Poor legislations could lead to problems in Turkana County and Kenya at large in areas of compensation over land displacement, community engagement drilling waste management, emissions, and land restoration. This is in line with Epstein *etal.* (2002), who noted from Garret Hardin 1968 tragedy of commons theory that the major problems in the life cycle of oil and gas exploration and production processes were regulation and governance of environmental resources that has always led to air, water and soil pollution, land and biodiversity degradation. They further noted that these problems in return affect the socio-economic characteristics negatively, with issues such as loss of livelihoods to the pastoralist communities, poor waste disposal, and displacement and conflicts as informed by

environmental scarcity theory. These issues range from local environmental degradation to ethnic clashes. Sustainable financial, social, human and natural capital as noted in sustainable livelihood theory. In the context of Turkana County of Kenya the environmental management outcomes are dependent on sound environmental management strategies. According to Odote (2015), sustainability in the management of the aspects above can be birthed from good institutions of governance, implementation of local and international legislation and policy frameworks, besides adoption of international best practices like IFC performance standards.

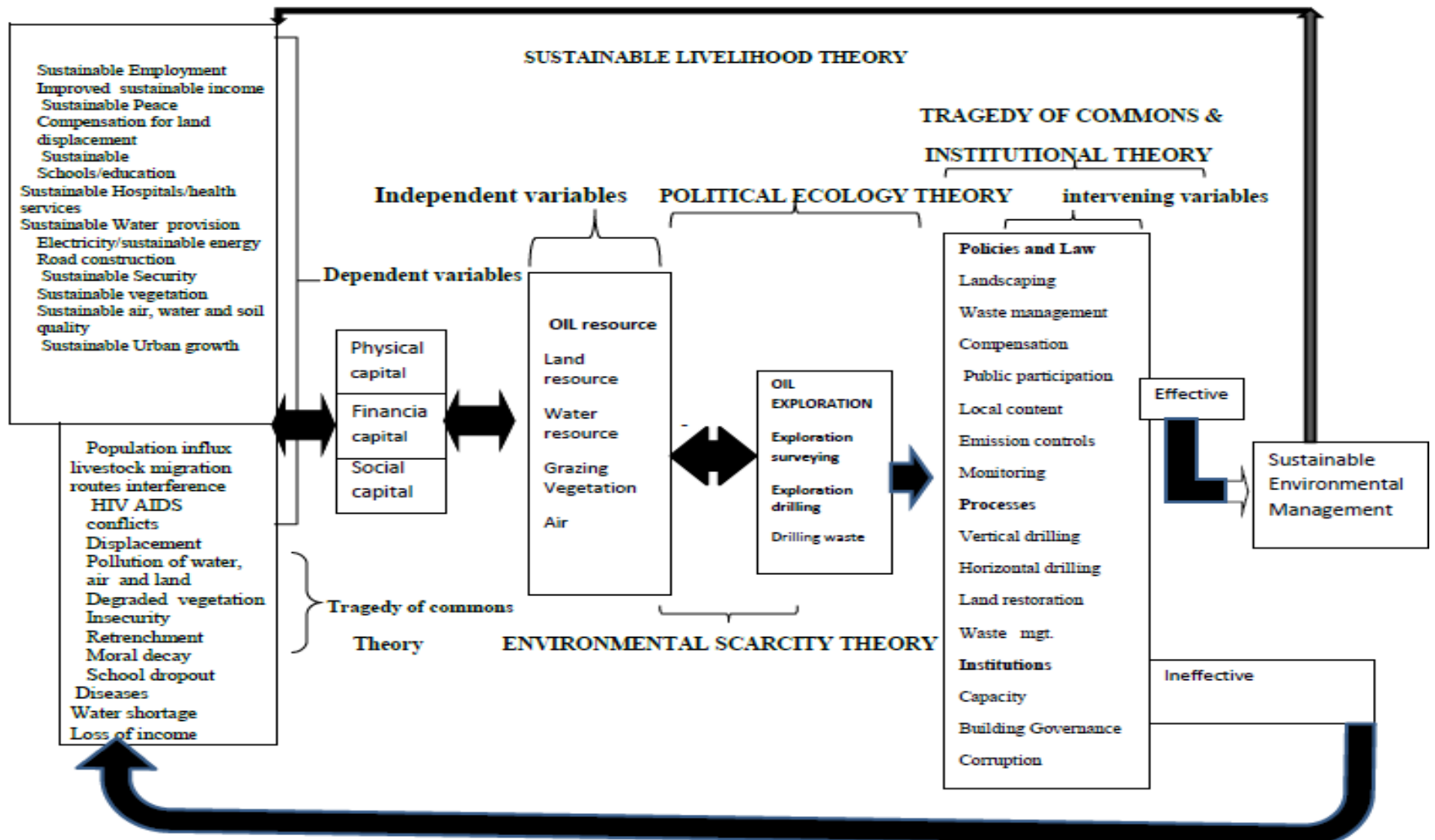


Figure 2.4 :Oil and gas exploration and sustainable environmental management conceptual framework (Source: Author,

2.7 Study Gap

Commercial quantities of crude oil was discovered in Kenya in 2012. Little academic research has been done on both the biophysical and socio-economic environment responses to the commercial oil and gas exploration venture and how sustainable management of these environments can be realised (Schilling & Locham, 2015). Studies done by Anyango (2015), shows a gap in research on legal, policy and institutional framework governing environmental management in the backdrop of oil and gas exploration in Kenya. Moreover few academic research showing how environmental management strategies in the Kenyan oil fields compare with the best practices globally have been done.

Studies done by Odote (2014) and Johannes *etal* (2017), on potential implication of oil and gas exploration on natural environment and social aspects of the locals in Turkana County were systematic studies, hence there lacks data on actual effects of oil and gas exploration on biophysical and socio-economic characteristics in Oil Block 13T South Lokichar Basin Turkana County. Lack of actual studies in Turkana comes amidst many positive and negative effects of oil and gas exploration as observed by Plänitz & Kuzu (2015), Ajugwo (2013), Agwu *etal.* (2016) and Kadafa & Ayub (2012). Management of environment in oil fields varies from one Country to another depending on the surrounding ecosystems, sources of livelihoods of the local communities, culture, political powers and institutions of governance. Understanding the specific issues affecting sustainable environmental management in Oil Block 13T South Lokichar Basin, Turkana County is very critical. This information is not available due to the limited number of academic researches that have been done in the area before. The identified research gaps justifies the significance of carrying out this study.

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The general objective of this study is to explore the effects of oil and gas exploration on the biophysical and socio-economic environment in Oil Block 13T South Lokichar Basin of Turkana County and come up with recommendations that would enhance sustainable environmental management in the area. This chapter focuses on the different techniques adopted in carrying out this research. Yin (2009), describes research methodology as a step by step approach in giving solution to a research problem. This chapter covers, study area, research design for the study, sample size and sampling techniques, methods of data collection and analysis.

3.2 Study Area Location

The study was carried out in Southern part of Turkana County in Oil Block 13T South Lokichar Basin marked in black in the study area map. Oil Block 13T straddles in three sub-counties of Turkana County, i.e., Loima, Turkana Central and Turkana South (Tulloch, 2017). The Oil Block 13T is a Cenozoic sedimentary basin in Kenya. It is part of the East African Rift tertiary system, though it is currently not active. The basin is approximately 25 km wide, 80 km long and has a maximum depth of above 7 km (Jarret, 2016). The study examined the effects of oil and gas exploration on biophysical and socio-economic environment in Southern Lokichar Basin that falls within Turkana South Sub-county. The Sub-County extends an area of 7,710.60 Km² (RoK, 2013).



3.2.1 Topography and Drainage

The physiographic landscapes in the county comprises of low lying open plains, river drainage patterns and mountain ranges. Lake Turkana is situated in the eastern part of the county at an elevation of 1,181 feet above the sea level with the surrounding basin being elevated at between 1,230-3,000 feet. Loima, Mogila, Songot, Kailongol, Silale Lorengippi, Kalapata and Loru, are the main mountain ranges of the county. The mountain ranges, due to their high elevation, are usually green, covered with condensed bushes and high woody cover (CGT, 2017). The ranges support important economic activities such as grazing during the dry seasons. The hills found in the county are; Tepes, Lokwanamor, Lorionotom, Pelekech, Lokichar and Loima, Natudao and Kasoroi hills. Lotikipi and Kalapata open lying Plains are also found in the study area (Earthview, 2012).

Rivers Turkwel, Tarach, Malimalite, Kerio, Kalapata and Lake Turkana form the main hydrology of the area. The Turkana County Integrated Development Plan 2013-2017 underscores that Lake Turkana is a natural heritage for the County and is the largest alkaline permanent desert lake in the world. The lake has no outlet and has reduced inflows and high rate of evaporation. The water level in the lake is subject to three or four years seasonal oscillations. River Omo, which is a permanent river from Ethiopia, drains into Lake Turkana. The lake is located on the eastern part of the county; it has a northern island, and has a wide variety of wild animals such as hippos, crocodiles and waterfowl. There are also numerous rivers that drain into the lake. These comprise of rivers Kerio, Turkwel and many more that are seasonal. There are several springs spread across the county, most sections of the lake zones and Turkana East. Other sources of

shallow water are periodic rivers (luggas) and water pans. There are very limited water pans, and earth dams around the study area since many of them dry up during the dry seasons. The pans found during the study area were unable to hold water throughout an entire dry season. The only river that passes through Lokichar ward where the study was carried out is the seasonal river Wei Wei shown in the study area map. The communities in Lokichar ward mostly depend on underground boreholes water.

3.2.2 Geology of the Study Area

According to Feibel (2011), a latitudinal cross-section of the oil block from South to North indicates that metamorphic sediments of the basement systems subjugate Southern strip (1.3° to 2° N). Tertiary rocks represented by alkali basalt; and Quaternary rocks consisting of soils, alluvium and iron stone cappings. He further notes that the central section shows superficial deposits of pleistocene to the recent age that occupy the Turkwel plain in the central section, (2° to $2^{\circ}30'$ N) while the western part according to Walsh (1996) is mainly made up of the metamorphic and igneous complex. Finally, he records that the northern part ($2^{\circ}30'$ to 3° N), has granulites folded, gneisses, schists and limestones of the basement system that are cut by acid pegmatites and basic intrusions. The main drainage in the study area is river Turkwel and underground water inform of boreholes and water pads constitute the largest source of water for the communities (Wendo, 2015). Turkana county has poorly developed soils due to aridity and perpetual erosion surface runoff and wind. Often coated by stone layers. Colluvial soils lean towards reddish colour over the basement system and usually grey buff or white over the volcanoes. Aeolian soils are sand dunes and could be active or fossil. Alluvial soils vary from gwet sands to flash flood silts, whereas black or brown clays exist locally in areas of impeded drainage (CGT, 2017).

3.2.3 Flora and Fauna of the Study Area

Turkana County Integrated Development Plan 2013-2017 observes that the county is dominated by vegetations that are adapted to the low rainfall seasons commonly referred to as the dry forest vegetation. These include the dwarf shrub land and woody plants that are not more than 1 meter high. Some species of this kind of vegetation comprises of the *Acacia reficiens*, *Indigofera spinosa*, and *Cadaba farinosa*. These plant species are vital sources of food for sheep and goats in the region. As noted about the topography of the area, there exist some hills in the study area such as Natudao, Kasoroi, and Lomokamar. Riverine forests dominated by tree species such as *Calotropis procera*, *Acacia tortilis*, *Acacia reficiens*, *Salvadora persica*, *Ziziphus mucronata* and *Delonix elata* exist on hills slopes and river banks. The area is mostly covered by shrubs, consisting of woody plants that are less than 8 meters in height and usually with many stems arising at the base. According to Okoti(2001), the key plant species in the area includes the *Acacia reficiens*, *Acacia tortilis*, *Calotropis procera* and single stands of *Boscia* spp and grassed shrubland. Grasses are the main vegetation cover while woody and herbaceous vegetation cover constitute around 6 - 20%. The most dominant grass species include *Eragrostis cilianensis*, *E. racemosa*, and *Chloris virgata*. *Acacia reficiens*, *Cadaba farino*. A study done by Ogutu *et al.* (2016), indicates that animal species found in the study area include, the Dwarf mongoose, Ground squirrel, the Cape hare, the Dik-dik and the Black-backed jackal. The area has very rich diversity of birds such as Chestnut-bellied sand grouse, Red-billed Hornbill, White-browed sparrow weaver, Black-headed Plover, Black-bellied go-away bird, Crested hoopoe, Eastern pale chanting goshawk, White-headed Buffalo-weaver, Superb Starling, Fork-tailed drongo, Brown-necked Raven, red and Yellow Barbet, Abyssinian roller, White-throated Bee-eater, among others. Reptiles such as Lizards and snakes are also present.

3.2.4 Climatic Conditions

Data from Meteorological Department of Kenya RoK(2015), indicates that the area, receives an average annual rainfall of between 200 and 400 mm and temperatures range between 24 to 38° C.The data also reveals that the area experiences dry season between August and February, and temperatures during these seasons vary between 26 and 40°C.The temperatures can fall to between 20 to 25°C during the rainy season; usually experienced between March and July.The long rains fall between April and August, while the short rains fall between October and November.The report also stipulates that rainfall is circulated on an east-west gradient with more precipitation in the western section and other areas of higher altitude and is lower in the northern region than in southern region sector of the study area.Rain falls in short-lived ferocious storms occasioning in flash floods, particularly in the northern part.

3.2.5 Ecological Zones of the Study Area

According to the County Integrated Development Plan 2013-2017,the agro-ecological zones of the area are appraised as, Inner lowland zone 6 (arid) 42 %, Inner lowland zone 7 (very arid) 38% Lower midland zone 5 (semi-arid) 3%, Inner midland zone 4 (transition) 1 %, Inner lowland zone 5 (semi-arid) 16 %, The dry forest cover in the county is held in trust by the County Government and the communities make use of all natural resources with no limitations. There is no gazetted forest in Turkana County.

3.2.6 County Administration of the Study Area

The County is administratively divided into seven sub-counties: Turkana North, Turkana South, Turkana West, Turkana East, Turkana West and Turkana Central, Loima and Kibish.There are 17 divisions,56 locations that are further sub-divided into

156 sub-locations. On the political units, the County has six political constituencies namely: Turkana North, Turkana West, Turkana Central, Loima, Turkana South and Turkana East constituencies, which in total are subdivided, into 30 wards. The sub-counties boundaries coincide with those of the constituencies. The study was carried out in Lokichar Ward in Turkana South Sub-County as shown in the study map in figure 3.1.

3.2.7 Population of the Study Area

Table 3.1: Population growth in Turkana County According to the Kenya Population and Housing Census 2009 results, the county population stood at 855,399. The average population growth rate of the county is 6.4% per annum. The trend of population growth since 1979 and the expected growth till 2039 if death rate and birth rate remains constant in the County is shown in table 3.1 below

1979	1989	1999	2009	2019	2029	2039
142,702	184,060	450,860	855,399	1,622,248	3,076,563	5,834,643

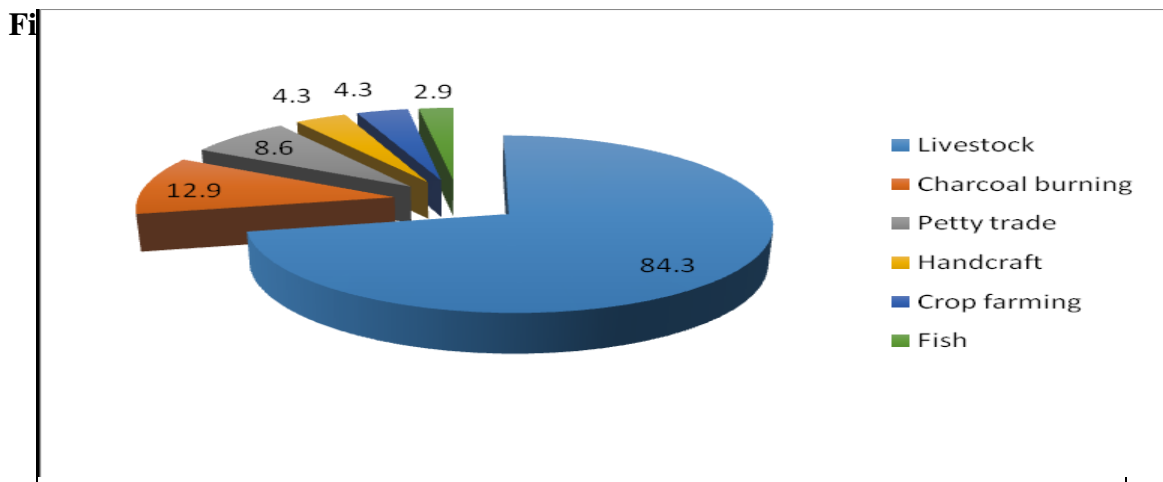
(Source: Kenya National Bureau of Statistics, 2010)

The current county population size is approximately 1,427,797. Lokichar ward is the former Lokichar location administrative units that have been replaced with the County Government devolved units since 2013. The total surface area of the Ward is approximately 2,899 km² and comprises of Kapese, Lokichar, Lochwangimatak and Napusimoru Sub-Locations of Turkana County (RoK, 2016). The current population

of the Lokichar ward is approximately 44,233 with a total number of 3696 households (KNBS,2010) and is projected to grow at the same rate with the county’s population growth rate.However Lokichar urban centre population growth might be higher due to the population influx as a result of the oil resource. The human population dynamics in the study area are small population size, less densely populated and sparsely distributed.

3.2.8 Socio-economic Activities

According to Opiyo *et al.* (2015),although weaving, trade, small-scale farming, tourism are practised in the area, pastoralism is the primary economic activity.Oxfam (2015) notes that 84% of the Turkana County locals’ source of livelihoods is livestock farming as shown in figure 3.2 below.



They further note that the local communities keep sheep, cattle, donkeys, camels, and goats. Also, they record that the livestock industry in the area is frequently confronted with various problems and key among them climatic shocks, cattle raiding and diseases. The average quantity of livestock per household according to Oxfam 2017 in Lokichar area is: 0 cattle, 7 goats,2 camels ,1 donkey and 3 sheep.The report notes that these numbers have reduced by more that 80% of the 2009 quantities. The study established

through a focused group discussion with the elders at Kapese village that cattle are found in limited areas (mainly in the north). However even in these areas most people have an average number of 5 cattle and only a few community members own very huge herds of cattle. The total number of livestock per Sub-County are shown in table 3.2 below

Table 3.2: Number of livestock in the study area

Sub County	Households	Sub County Household livestock holding size					Sub county Livestock population				
		Goats	Sheep	Cattle	Camel	Donkey	Goats	Sheep	Cattle	Camel	Donkey
Central	21,357	48	13	1	2	2	1,025,121	277,637	21,357	42,713	42713
Loima	30,263	18	7				544,737	211,842			
South	19,650	87	33	5	8	3	1,709,571	648,458		157,202	58951
North	17,815	45	11	5			801,686	195,968	89076	98,251	
West	34,129	4	5	1		2	136,515	170,644	34,129		
East	15,853	29	10	1	1	1	459,732	158,528	15,853	15,853	15853
	139,067						4,677,362	1,663,077	160,415	314,019	117,517
Moderated Total Livestock Population Turkana County							2,619,323	931,323	89,832	175,851	65,809

(Source:OXFAM, 2015)

Schilling *et al.* (2015), records that cattle rustling among the Pokot, Turkana, Samburu and raiders from neighbouring Southern Sudan are the significant drawbacks for livestock rearing and the frequent drought in this area further exacerbates the problem. There are some other challenges apart from the conflicts aforementioned that do face the local communities and key among them is the lack of abattoirs, and this denies the farmers a ready market for their livestock products. Opiyo *et al.*, (2015), reveals that there are some agricultural activities along the Turkwel river where irrigation schemes

such as Katilu and Koputiro have been established. They further note that rain-fed agriculture is practised in small scale since rainfall in the area is quite unreliable. The chief crops grown along the river include millet, beans maize, cassava kales, cabbages, bananas, and tomatoes. These entire crops cultivated along the river are a source of food for almost the whole of Turkana region, with deficit supplemented with supplies from Kitale area. According to the Turkana County Integrated Plan 2017 on matters health services, the doctors population ratio is 1:70000,nurse to population ratio is 1:5200.In regard to education sector the County has 682 ECD with an enrolment of 101,094 pupils, 338 primary schools, 33 secondary schools ,2 University Campuses and 2 colleges.

3.3 Research Design

This study adopted the exploratory mixed method research design to answer the three research questions. According to Creswell and Clark (2007),the exploratory mixed method research design is carried out about a research problem when there are few or no previous studies to refer to or rely upon to foretell an outcome. The focus is on gaining insights and understanding for later research or undertaken when research problems are in the initial stages of the study. The design was adopted in this study since oil and gas exploration is a new venture in Kenya and little research on how the oil and gas exploration activities are affecting the socio-economic and biophysical environment in Oil Block 13T South Lokichar Basin has been done. Exploratory mixed methods research design comprises of combination of several research designs or different data (both qualitative and quantitative) collection and analyses approaches (Kothari,2004).The research design provides a leeway of triangulation which is the use of numerous means such as data sources, methods, and researchers to scrutinise the

same phenomenon(Meissner *etal.*,2011).Triangulation allows researchers to enhance the validity of their findings if they compare the different data sets on the same issue (Creswell and Clark,2007).

The exploratory mixed method research design adopted in this study made use of a combination of three different research designs namely; exploratory case study research design, descriptive research design and experimental(Post-test only and One-shot experimental) research design as discussed in section 3.3.1,3.3.2 and 3.3.3 below.Many studies in both social and applied sciences have used mixed method research designs to enhance knowledge of various phenomena.Adams(2004);Buhr,Inomiesa(2015),Dillard&Layzell(2014);Deegan&Bloquist,(2016),Livesey&Kearin(2002),Lauwo&Otusanya(2014),(2005),Samkin&Schneider(2010);Tregidga & Milne(2006),successfully used mixed method research designs in their studies .Buhr (1998), used a combination of a single case study, descriptive and experimental research designs in research of a mining company in Canada to provide an in-depth analysis of how Political Ecology theory could describe corporate revelation of critical environmental issues as a result of mining activities.Tregidga & Milne (2006), applied a case study research design combined with descriptive research design to explore how one New Zealand organisation developed itself over time within the context of environmental sustainability.Inomiesa(2015), used a combination of descriptive research design and case study design to show how oil activities had affected Uzere community in Niger Delta region of the Federal Government of Nigeria.

3.3.1 Exploratory Case Study Design

According to Yin (2009), a case study is an empirical inquiry that examines in-depth details of modern-day occurrences and within its everyday context, especially when the confines between phenomenon and circumstances are not apparent. Oil Block 13T South Lokichar Basin in Lokichar ward was used as a case study area for in-depth analysis of oil and gas exploration effects on biophysical and socio-economic environment in Turkana County and other parts of Kenya. The study focused on the exploration activities effects on the environment and tried to identify how these activities can sustainably be carried out in Turkana County and other parts of Kenya. A case study research design was adopted in this combination of research designs as it enhances comprehension of an occurrence or exercise by an in-depth examination (Lee *et al.*, 2007). The context of this study focused on oil and gas exploration activities and its effect on land cover, underground water resource, atmosphere and socio-economic characteristics of the communities. The design was conceptualised to help in assessing the management strategies in place by the oil companies and recommend sustainable management practices.

Fundamentally, the oil and gas exploration activities in Turkana Kenya represent numerous cases for this study, which are but a subset of all exploration activities being carried out countrywide. Based on the research objectives, the design comprised of various phases. One was the proposal, and it entailed exploratory inquiry to gain further insight problem definition and development of a research plan. The second phase involved the empirical enquiry through the review of literature on oil and gas exploration effects on the socio-economic and biophysical environment globally. The third phase was a pilot study to pre-test 10% of the questionnaires to allow significant observations regarding the response time and clarity of questions. Data collection on

the various socio-economic characteristics before and after the oil and gas exploration was the fourth phase by use of questionnaires and four focused group discussions comprised of the community elders to get their perspective of exploration activities impact to their traditional way of lives. Descriptive research design, post-test only and one shot experimental research design were combined with this research design to enhance the full understanding of the objectives investigated.

3.3.2 Exploratory Descriptive Research Design

According to Knupfer & McLellan (1996), the descriptive research design is normally used to acquire information and illustrate current position of phenomena with reverence to variables in the circumstances. They further note that it allows the gathering of both quantitative and qualitative data with no changes in research context and deals with naturally occurring phenomena, where the researcher has no control over variables. Kothari (2004), indicates that descriptive research design also yields rich data that allows detailed analysis leading to useful study recommendations. However, as noted by Nassiuma (2000), the design has a probability of error and subjectivity when respondents are unwilling to provide desired information or a researcher ignores data that does not conform to research hypothesis. This study, which had a clear scope, considered this design suitable since it provided room for enhancing reliability by reducing variability and minimising bias through the choice of a more appropriate sampling technique. Since descriptive approach is more of a statistical study than investigation and is the foundation for conducting a survey investigation (Kothari, 2004), this study found it relevant. The design got used in describing the averages, the frequencies and other statistical calculations of socio-economic issues investigated. Description research design was also used in objective number two in

trying to describe the trends of land cover changes in the study area, by use of digital imagery acquisition and analysis an approach adopted from Huang & Huang(2014).

3.3.3 Exploratory Post-Test Only and One-Shot Experimental Design

The exploratory post-test only experimental design was applied on objective two on analysis of the collected water samples from the community boreholes while exploratory one-shot experimental design case design got applied on analysis of mud cuttings waste materials sampled from Twiga1 reserve pit. The post-test design involves randomly gathering a set of the unit for analysis that is thought to have had treatment intervention and a control category from whom the intervention is withheld (White & Sabarwal,2014). In this study, the water samples from the community boreholes were sampled and analysed in the laboratory. Consistent with post-test only experiment study approach explicated by White & Sabarwal (2014), the boreholes whose water were sampled were, Sale-yard, Nakukulus, ACS and Lokichanda boreholes and the baseline information before the oil and gas exploration began from the study done in 2012, acted as category whose intervention was withheld. Ecosystems disturbances in the area due to oil and gas exploration activities were considered to be the potential treatment interventions. The assumption of the potential impact of oil and gas explorations activities on the boreholes water was made by comparing the variation on the parameters of the water samples analysed and those of similar boreholes before the commencement of oil and gas exploration in 2012. One-shot experimental case design was used to sample the mud cuttings from Twiga 1 reserve pit. One-shot experimental case design is a type of experimental design where a single group of test units gets subjected to experimental treatment, and a single measurement taken afterward (Kelly,2011).

3.4 Sample Size Determination for the Number of Households

The sample size for the respondents was determined from the study areas' total number of households within Lokichar Ward which was 3696 (RoK, 2017). The sample universe was determined using a sample size determination formula formulated by Yamane (1967) and explained by Israel (2009) as indicated below to obtain the ideal sample size of the households.

At 95% confidence level and precision (e) = 0.05, n is the sample size, N is the population size,

$$n = \frac{N}{1+Ne^2} = \frac{3696}{1+3696(0.05)^2} = 361 \text{ households}$$

3.5 Sampling Procedure

The study sampled 361 households. Determination of the sample size is shown in section 3.3 above. The research adopted stratified simple random sampling technique in identifying the specific households. The eleven villages; Kamarese village, Akanapus, Naoyatira, Narengellup, Nacholla, Lokoridoyo, Tinyouta, Nalemskoni, Nakukulus, Kapese and Lokicheda village formed the strata for sampling. From each stratum a sample size of 33 households was taken giving rise to a total sample size of 361. Pastoralists live in a large fenced homestead called the 'Manyattas' containing several households each with about 200 households. Each of these villages had an average of 3 established *Manyattas*. Kapese and Lokicheda villages formed the periurban areas and these villages had densely constructed semi-permanent and temporary settlement but with similar characteristics to the *Manyattas* where people of the same household lived in a homestead with their houses next to each other.

The *Manyattas* were simple randomly picked one from each village. The 33 households from each *Manyatta* were simple randomly sampled. The households from the two villages without established *Manyattas* were simple randomly sampled too. From each homestead both within the established *Manyatta* and the two villages homestead the head of the homestead was interviewed and in their absence, the eldest child in the household was interviewed. In the Turkana community, the village elders have the final say on all matters in the homestead hence the necessity of sampling the homestead heads.

Shi (2015), indicates that stratification does not imply any departure from probability sampling. It simply requires the division of the population into sub populations called stratum and that probability sampling is conducted independently within each stratum. In addition to household survey, four Focused Group Discussion (FGD) were simple randomly conducted in four villages; Lokicheda, Nakukulus, Kamarese and Kapese to authenticate information collected from other sources. The key informant resource persons were purposively sampled for detailed interview. These key informants were; Oil company officials (Communication officials, Human resource, Lead environmentalist and Field environmentalist). The local leaders, the NGO officials, WRA official, NEMA official, Meteorological Department of Kenya Official, the Headteachers of the surrounding schools, the ICCL hazardous waste management company official, the Officer Commanding Station of Lokichar Police Station, Sub-County Commissioner, Turkana South Sub-County, Lokichar Location local Chief and officers at the Ministry of Petroleum and Mining, In addition, the study interviewed the business investors within Lokichar town.

The various business categories were mapped and similar ventures were clustered together. Clusters of those in hotels business, the retail shops business, and the guest

house business got sampled. All the individuals in the clusters got sampled since the population sample size of the business community in Lokichar town is small. The sample collection procedure for data on oil and gas exploration effects on biophysical environment water component entailed sampling of all permanent community water boreholes. The area of study had 7 community boreholes, but only four boreholes were purposively sampled since they are the ones that had a baseline information data and had water throughout the year 2017. 2.5 litres of water samples from each borehole were drawn thrice a day (in the morning, noon and evening), on quarterly basis and two drops of concentrated nitric acid pipetted to preserve the samples in accordance to the WHO sampling standards and procedure (Gorchev & Ozolins, 2011). A total of 36 samples were sampled and analysed for adequate representation of the water quality. The drill cuttings were sampled as shown in appendix 7.8 from Twiga 1 which is the NEMA Licensed temporary storage site for the drill waste materials for the oil exploring companies in oil Block 13T, South Lokichar Basin.

Secondary temperature data of the environment around oil Block 13T, South Lokichar Basin where oil drilling activities were being carried out was acquired in addition to primary data collected. The effects of oil and gas exploration on the land cover around the entire area where the drilling of the 11 exploratory and appraisal wells had taken place got examined by assessing the trend of the vegetation land cover changes and NDVI of the study area.

Table 3.3 Population Sample Frame

Respondents	Size	Informants
Households	361	361 Head of the households in the villages
Business communities	Four business categories	21 business owners Lokichar town
Administrators	2	County commissioner/Deputy commissioner, Lokichar chief
County officials.	5	Lokichar ward MCA, County administrator of environment, 4 Health officers of Health facilities in the study area, Policy in charge of Turkana County,
Institutions	5	WRA official Lodwar office, Meteorological official Lodwar, NEMA official Lodwar, a Ministry of Petroleum and mining official Nairobi office. KPLC official Lokichar Substation, National Museum official Nairobi office
Oil Company Officials	5	Lead Environmental manager Tullow BV Kenya Ltd., The Director of communications Tullow BV Kenya Ltd, Technical Director Tullow BV Kenya Ltd, Company Cooperate Affairs Advisor and Community Liaison Officer Tullow BV Kenya Ltd
NGOs	4	Executive Director FOLT and Programme Coordinator, Oxfam official based at Lodwar, TUPADO official, World vision official Lodwar
CBOs	2	Pastoralists' association (Alemun pastrolist group official) leader Business association leader in Lokichar area,
Community leaders	13	3 Headteachers(Lokichar mixed, Uhuru girls, Kapese primary school), 1 Teacher (Nameskoni primary school), 4 Youth Leaders Turkana South Sub county Lokichar ward, 2 Women group leader Turkana South Sub county Lokichar Ward, 3 Religious leaders from Turkana South Sub-County Lokichar
Total	420 respondents	

(Data Source: Field survey, 2017)

3.6 Data Type and Collection Techniques

The study adopted mixed method data collection approach (qualitative and quantitative data) across the various objectives. Both primary and secondary data were collected.

3.7 Data Collection on Constitutional, Policy, Legal and Institutional Framework Governing Oil and Gas Exploration and Environmental Management in Kenya

3.7.1 Document Review

According to Wright *et al.* (2007), document review is a technique of data gathering that entails analysis of content from transcribed documents to make accurate inferences based on the study parameters. This technique was used in data collection for objective one ; the review of the legal, institution and policy framework in Kenya. The key documents reviewed included; National Energy and Petroleum Draft Policy 2015, the National Water Policy of 2012, The Wildlife Policy 2013, National Environmental Policy 2013. The study reviewed legislations such as, Petroleum Act 2019, Constitution of Kenya 2010, the EMCA CAP. 387, the Water Act 2016, and the Land Act 2012 Energy Act 2019. In addition, the study examined several international conventions such as; the Convention on Biological Diversity, the Bonn Convention, the International Labour Organisation (ILO), Convention on Indigenous and tribal people and the Basel Convention on the Control of Trans boundary Movement of Hazardous Wastes and their Disposal. The study looked at other international environmental sustainability performance standards such as those of International Finance Cooperation.

3.8 Data Collection on Oil and Gas Exploration Effects on the Biophysical Environment

This objective looked at several aspects of the biophysical environment that is the vegetation cover; drill cuttings waste disposal effect on land and soil, the physical-chemical properties of underground water (community boreholes), air pollution, dust emission and light pollution.

3.8.1 Digital Satellite Imagery Acquisition for Land Cover Change.

According to Chary & Sreenivas(2011), digital satellite imagery acquisition also referred to as digital imaging, entails the formation of photographic imageries like the imageries on land cover changes, or floods and other resources. It involves imagery processing which may comprise of acquiring the imagery from the dataset such as, Landsat, Sentinel and Quick bird among others. It also includes imagery compression, storage, and printing of such imageries. The technique got applied in the management of the objective two data on land cover changes component. The procedure for data collection entailed mapping the eleven oil Well pads in the study area and other excavations done such as access roads and oil company office suites by use of a GPS mapper. The mapped coordinates were then used to acquire the Landsat 5 Landsat 8 satellite imageries six years before the oil and gas exploration activities began and six years after the oil activities began for both rainy and dry seasons from the Earth Explorer. The study compared the images of the dry and rainy season pre and post oil and gas exploration activities. The images were processed using the ArcGIS 10.3 software and Erdas. The study also made use of photography and observation in collecting data on the effect of oil and gas exploration activities on the vegetation cover and the implication of clearing vegetation to the wildlife and pastrolism.

3.8.2 Data on Underground Water Quality

3.8.2.1 Sampling Borehole Water by use of Fixed Volume Purge and Sample Technique

The data on water quality was acquired through field measurement, laboratory analysis of the samples as described in the collection method section. It entailed quantitative data that was interpreted to give the qualitative aspect of the water component. The sample for physical properties of water analysed in the field got collected by drawing one litre of water on site from the four boreholes and the P.H, and Turbidity parameters of the water were measured. In the analysis of the heavy metal contents and TDS, 2.5 litres of water samples from each of the four community boreholes were drawn thrice in the four boreholes on quarterly basis for one year and in total, 48 samples were collected in accordance to the WHO borehole sampling standards and procedure (WHO,1997). The water samples were put in sterile glass bottles and placed in an insulated light-proof box containing ice packs whose internal temperatures was 4-degrees centigrade and transported for laboratory analysis of the chemical properties, which purely focused on selected heavy metals concentration. According to Gorchev & Ozolins(2011),three borehole sampling techniques are typically applied. These methods are fixed volume purging followed by sampling, low flow sampling, and passive sampling methods.

They further explain that the fixed volume purge & sample technique involves pumping of a volume of water usually 3 or more times from the well lining and then sampling gets done. This study adopted the fixed volume purge and sample method where three volumes of water were pumped out before sampling. Also, they denote that in most cases, purge volumes can be minimised by checking for physical-chemical parameters stability as pumping is being carried out. The parameters tested were P.H and Turbidity,

and these were the physical parameters that were of interest to the study. They further note that the technique is very efficient in routine monitoring of boreholes and it does not require a specialist. The fact that the use of this technique can get deeper boreholes samples justified its choice. The Low flow purging and sampling techniques and passive sampling (Zero purges) can only get used for short-screened monitoring boreholes. Low flow purging and sampling techniques require the water pumped at a rate of 0.5 litres per minute. In passive sampling, passive sampling tools are needed to collect samples at distinct depths in the borehole column with minimal disruption.

3.8.3. Soil Samples Heavy Metal Concentration Data from Twiga 1 Well pad Environs

The study made use of the heavy metals concentration analysis reports done by SGS Kenya from Tullow BV Kenya Ltd. The data was from the samples collected around Twiga 1 well pad site in July 2017. In the absence of local regulation on soil standards, the analysis results got assessed against the Intervention values in the Dutch soil remediation circular 2013. The soil sampling points and locations were summarised as shown in appendix 7.11

3.8.4 Mud Cuttings Sampling Technique

The mud cuttings were purposively sampled from Twiga 1 Well pad shown on appendix 7.8 and analysed to determine the concentration of heavy metals. Sampling was carried out in Twiga 1 because the site had been licenced by NEMA to be a temporary storage site of the drill cuttings generated from all the Well pads being drilled within Oil Block 13T South Lokichar Basin. The study adopted a sampling procedure

used on API Site 4 in Louisiana Gulf Coast (Deuel and Holliday,1990) and Iranian onshore site mud pits sampling (Taylor,2014).

The reserve pit had a rectangular shape whose dimensions are 16 m length, 9 m width \times 3 m depth as shown in figure 3.3 .The sampling was done by sub dividing the reserve pit into three layers; surface layer, middle layer and bottom layer.The drill cuttings collection points were georeferenced and were dug through using an auger and an hatchet and the middle and the bottom layers samples scooped as shown in appendix 7.8

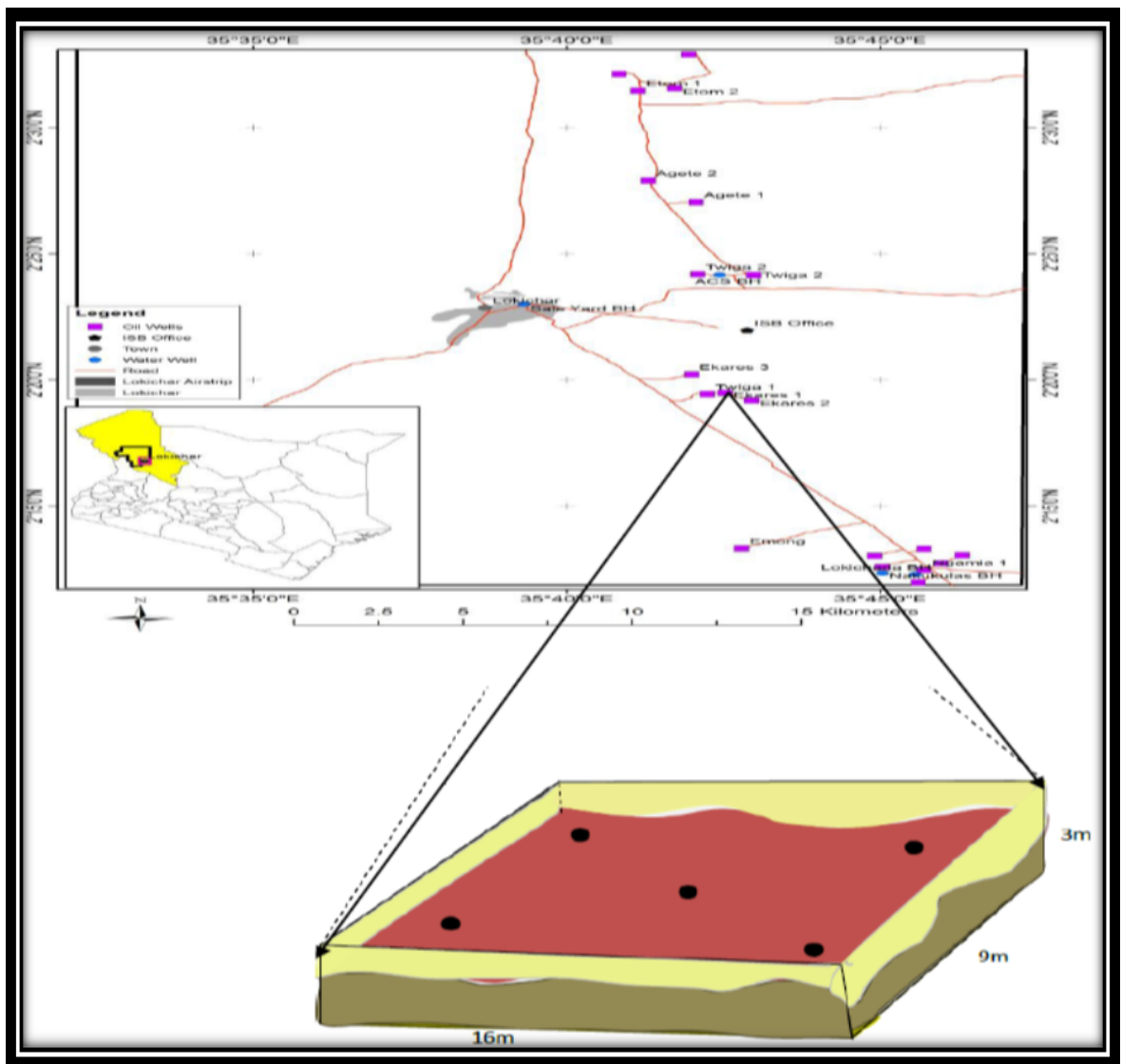


Figure 3.3:Sampling points for the drill cuttings in Twiga 1 reserve pit (Source:Field survey, 2017)

Samples were picked in all the layers diagonally at three uniformly spaced depths. Triplicate samples were selected from every point and then collective to form a single composite sample for that point. A total of fifteen samples were collected, five from each layer of the pit. The samples were well labelled and put in clean polythene bags and taken to the laboratory for analysis.

3.8.5 Data on Air, Dust, Noise and Light Pollution

3.8.5.1 Document Review, Observation and Photography

According to Wright *etal.*,(2007) document review entails systematic data collection from available records. These records may include the financial, annual or monthly reports. It is a secure method of data collection. Changes on atmospheric temperatures may arise from gas flaring during well testing. Secondary data from the Kenya Meteorological Department records on temperature changes for Turkana South Sub-County for the period between 1990-2017 was examined. Keen interest was paid on the temperature recordings since the oil and gas exploration activities began in 2011 because emission of greenhouse gases from the mining areas has the potential of retaining more heat. Observation on dust emissions and gas flaring were also made in the study area. Photography on gas flaring during well testing, light pollution was also done. In addition, the locals views in regard to environmental pollution were also noted.

3.9 Data Collection on Oil and Gas Exploration Effects on Socio-economic Characteristics of the Locals

Both quantitative and qualitative primary and secondary data were collected. The quantitative primary data on the effects of oil and gas exploration on socio-economic characteristics entailed; the income of the locals pre and after the oil and gas exploration activities began, the number of reported conflicts cases to the administrators and oil companies between the oil companies and the locals or inter clan/community conflicts due to oil resource exploration activities, infrastructure developed through observation, school enrolments in the area number of health facility constructed, schools projects put up by the oil companies through their CSR programs, the roads constructed, the prices of accommodation services before the oil and gas exploration activities began and after, the number of jobs/employment created by the oil and gas exploration activities in the area, number of families displaced from their community land and changes on selected business turnover as a result of oil and gas exploration activities. The qualitative data in objective one entailed cultural and moral aspect situation, people's perception in regard to waste management, livestock migration routes, community participation and engagement by the oil companies, gender equality issues in respect to job opportunities, capacity building by the oil companies to the locals and security status of the area since exploration activities began. The secondary data entailed data on human populations in the study area and data on health records from the hospitals and DHIS Kenya. Interviews, observations, questionnaires, photography, focused group discussions were the primary data collection tools, while documents review was the main secondary data collection tool.

3.9.1 Use of Questionnaires

90% of the data on objective three that is ,the impact of oil and gas exploration on the socio- economic characteristics of the local communities was collected using questionnaires. According to Wakahiu *et al.*,(2016,) questionnaires are mostly used in the collection of primary data from individuals.The questionnaires were designed with the research questions in mind. Both open-ended and closed-ended questions were formulated as shown in the appended questionnaires. An open-ended item allows the respondents to give the personal opinions and they usually provide more than the required.They further note that questionnaires attitudes can be examined with quantitative approaches by allocating statistical values to Likert-type scales.With questionnaires, it is easier to perform a pretest and posttest for analysis.

The questionnaires used to generate primary data from the household were structured in such a way that all the three primary objectives were well captured.The dependent variables that were collected using a questionnaire for objective number three, on the oil and gas exploration effect on socio-economic characteristics entailed the income of the locals pre and after the oil and gas exploration activities began, the number of reported conflicts cases to the administrators and oil companies,between the oil companies and the locals or inter clan/community conflicts due to oil resource exploration activities, infrastructure developed through using questionnaires and observations method,school enrolments in the area number of health facility constructed, schools built by the oil companies through their CSR programs and the roads made.Other variables entailed the number of jobs/employment created by the oil and gas exploration companies in the area,security status of the area,land displacement of the locals from their community land, and cultural and moral aspect situation.

The questionnaires were designed in likert scale of 1-4;with 1 representing adequate,2 moderate,3,inadequate and 4 poor for some variables ,1 to a great extent,2 moderate extent,3 less extent,4 not at all for other variables.In analysis of the conflicts cases in the study area a likert scale of 1-5 with 1 representing very high,2 high,3 moderate,4 low ,5 rare was designed.

3.9.2 Observation

The observation was used in collecting data for both objective one and two.Data collected using this method include, the projects done through cooperate social responsibility of the oil companies; such as health facilities constructed, schools developmental projects, roads constructed, degradation of land cover and waste disposal strategies. According to Crosby *etal.*(2006), observation avails an opportunity for the study of the dynamics of a situation. It is instrumental in providing additional information.

3.9.3 Photography

The technique was applied during the study for documentation and evidence purposes of the various aspects that were researched in the field. The different oil companies CSR projects mostly addressed by objective number three on the impact of oil and gas exploration activities on socio-economic characteristics were captured using this technique as illustrated in the results and discussion section. Some images obtained through this technique include, the schools dormitories constructed, hospitals constructed, access roads, water tanks installed and, focused group discussion meeting in the study area at Lokichar.According to Flick (2009), photographs in most cases are

used in supplementing verbal data and they provide less biased recordings as compared to observation and this is why they were used hand in hand in this study.

3.9.4 Interviews

The method was applied in collecting data from all the key informants as shown in table 3.1. The study applied both structured and semi-structured interviews in data collection. Data on how the oil company was managing the waste material, whether the oil companies were employing the locals, the challenges the oil companies were facing regarding resolving the conflicts and if the disputes were there, between them and the local communities was conducted from the oil company officials. Data on whether the business community had experienced changes in their monthly turnovers was obtained from the business communities and business leaders. Data on conflict cases reported to the local administrators and how they were resolving them was obtained from the local administrators mostly the chief and the Sub-County commissioner and from local NGOs. Data on the effects of oil and gas exploration on education in the area was gotten from the headteachers and County Director of education. Data on waste management from the oil fields, vegetation degradation and environmental restoration was gotten from WRA, NEMA and Turkana County Director of environment. Data on security was collected from the local government administrators and OCS Lokichar police station. The locals' attitude in regard to above issues in addition to their perception on the levels of engagement by the oil companies, security, moral values, culture and traditions, health issues and well-being, water, services, and compensation was mostly gathered using these techniques from the community and religious leaders.

3.9.5 Focused Group Discussion

Among the Turkana community the village elders have the final say on all matters in the community. In addition to the household survey, a total of four focused group discussions were simple randomly conducted in four villages that is, Lokicheda, Nakukulus, Kamarese and Kapese villages with the elders. Data on land displacement and the level of community participation and engagement over oil and gas exploration matters, effects of oil and gas exploration activities on livestock migration routes, the effects of oil and gas exploration on the cultural and heritage endowments of the study area, the moral decadency issues and their views on the locals health issues and oil and gas exploration was collected through these focused group discussion. See a photo of a focused group discussion at Kapese in appendix 7.9.

3.9.6 Data collection summary

Table 3.4: Data collection summary table

Objectives	Variables			Data collection tools
	Independent	Intervening	Dependent	
Objective 1 Constitutional Policy, Legal & Institutional Framework governing oil and gas exploration in Kenya		Policies, the institutions of governance, Regulatory legal framework		Document review, check lists Interviews with key informants
Objective 2: Oil and gas exploration. Effects on the biophysical environment	Oil and gas exploration, soil, land, water vegetation Drill cuttings waste materials	Policies, institution of governance, the Regulatory, legal framework. Process in waste ,transportation of crude oil, and management of emitted gases, land restoration	Water physicochemical properties(P.H,Turbidity, TDS ,Selected heavy metals(,Ni,Cu,Hg,Pb, Cr,Ca,K,Ba,Mn & Fe), vegetation cover, air quality, Drill cuttings waste material heavy metal contents concentration	Document review on policies and legal frameworks and soil data, questionnaire, water samples collection and analysis .land sat Imagery acquisition and analysis by use of Arc Gis, photography, observation Focused group discussion, Interviews
Objective 3: Oil and gas exploration. Effects on socio-economic characteristic	Livelihoods Social-cohesion Social& physical infrastructure Natural resources(vegetation, water, oil)	Policies, Institutions of governance, policies and legal framework Processes CSR	Income, education, conflicts cases, employment, health facilities and health issues, population influx, HIV cases, compensation & Land displacement, security, Urban growth, moral decay livestock migration, road, water infrastructures	Questionnaires, document review, photography, observation Interview schedule Focused group discussion

3.10 Data Analysis Methods

3.10.1 Document Review on Constitutional, Policy, Legal and Institutional Framework

A review of the various policy documents and legislations that relates to oil exploration and environmental management was done in reference to their conformity to the Kenya Constitution 2010 and International Finance Cooperation standards and other global best practices in oil and gas exploration fields. The environmental management practices in Oil Block 13T South Lokichar Basin by the oil exploring companies, the National and the County Governments, together with other environmental governance agencies were assessed to see their conformity to the existing national and international environmental laws.

3.10.2 Data Analysis on Oil and Gas Exploration Effects on the Biophysical Environment

3.10.2.1 Arc-GIS Analysis of Land Cover/Land use Changes

The objective two data on land cover changes aspect, attributed to numerous negative effects on the pastoral communities in the area were analysed using Arc-GIS 10.3 software. Landsat 5 TM and Landsat 8 OLI/TIRS medium resolution digital satellite images, for the total study area containing Well pads, access roads and ISB land were acquired six years before the oil and gas exploration activities began and six years after for both the rainy and dry seasons; 2006 to 2011 and 2012 to 2017. The Well pads, the access roads and the ISB site were geo-referenced, and their imageries acquired. The digital images showing changes on the land cover of the study area were processed and presented in form of maps.

According to Kobben (2011), Arc-GIS has two ways of classifying digital images that is, supervised and unsupervised. The study made use of supervised classification which mostly depends on the researchers understanding of the study area to achieve the set objectives. The classification process entailed imagery restoration, classification, and enhancement. According to Price(2011), in Arc-GIS, the classification of imageries follow typically the steps shown in the imagery categorisation workflow in figure 3.4 below.

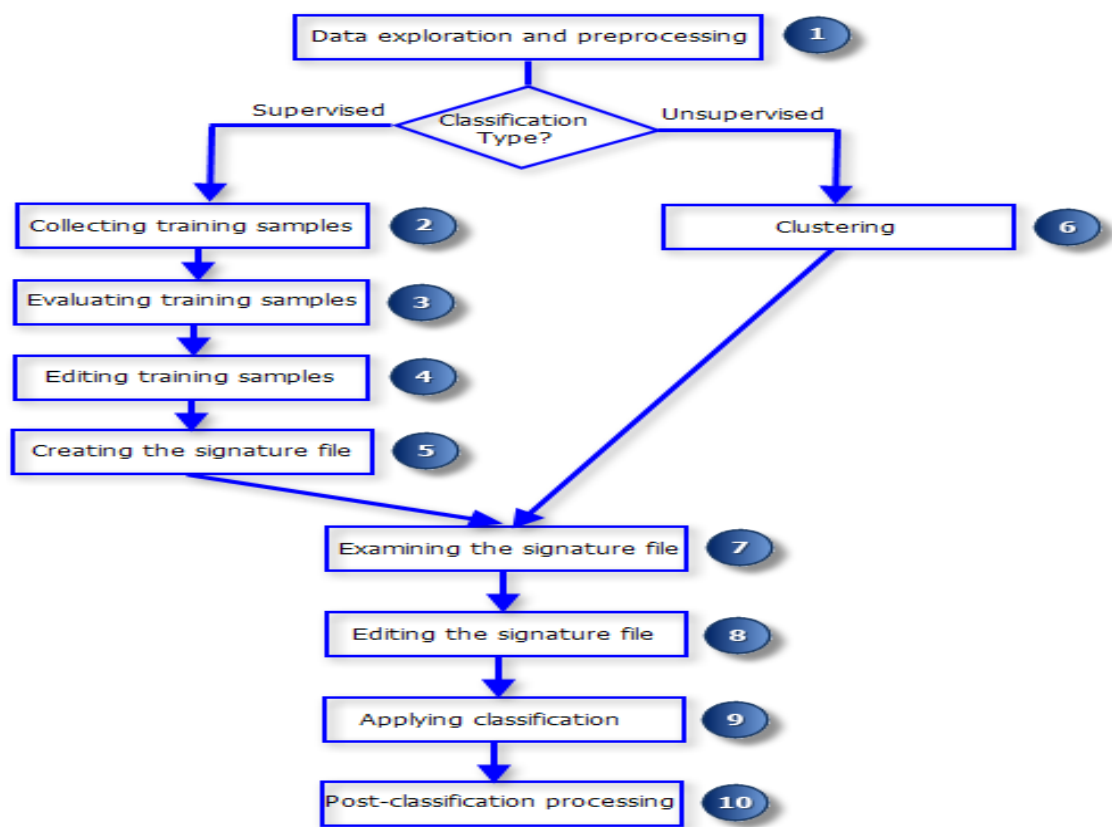


Figure 3.4:Steps in Digital Imagery Analysis (Source: ESRI, 2010)

Below is the summary of the digital imagery analysis process above (i) Exhibit 3 band composite imageries. (ii) Select symbolic training samples for the preferred classes (iii) make manage and appraise signature file (iv) Implement the maximum likelihood classification tool and (v) Color code and display the categorized imagery. For higher precision, images were further processed to eliminate noises and insulated areas for enhanced output quality. Further processing involved smoothing and clumping, filtering and simplifying output maps. Apart from the land cover images classified, the Normalised vegetation index for the study got determined and compared for the periods before and after oil and gas exploration.

According to Govaerts & Verhulst(2010), Normalised Difference Vegetation Index (NDVI) is often used worldwide to monitor drought, monitor and predict agricultural production, assist in predicting dangerous fire zones, determine vegetation cover and map desert encroachment. NDVI is preferred for global vegetation monitoring because it helps compensate for changing illumination conditions, surface slope, aspect, and other extraneous factors. It also allows one to generate an imagery displaying greenness(relative biomass). NDVI takes advantage of the contrast of the characteristics of two bands from a multispectral raster dataset - the chlorophyll pigment absorptions in the red band and the high reflectivity of plant materials in the near-infrared (NIR) band. The differential reflection in the red (R) and infrared (IR) bands enables one to monitor density and intensity of green vegetation growth using the spectral reflectivity of solar radiation.

Further, they explain that green leaves commonly show better reflection in the near-infrared wavelength range than in visible wavelength ranges. Also, they do state that

when leaves are water stressed, diseased, or dead, they become more yellow and reflect significantly less in the near-infrared range. Their study also illustrates that clouds, water and snow show better reflection in the visible spectrum than in the near-infrared range, while the difference is almost zero for rock and bare soil. Yin *et al.* (2012), denotes that the NDVI process creates a single-band data set that mainly represents greenery. The negative values represent clouds, water and snow, and values near zero represent rock and bare soil. The Red and NIR represent the spectral reflectance value, as noted in the red and near-infrared (NIR) ranges in the spectrum. The value for NDVI ranges between -1 and +1. Vegetation has an NDVI range of between 0.1 and 1 according to Wang & Gong, (2009)). They further indicate that the higher the NDVI, the higher the fraction of live green vegetation found in a given area. The documented and default NDVI equation according to Kaspersen *et al.* (2015) is; $NDVI = (IR - R) / (IR + R)$. The IR is the pixel values from the Infrared band, and the R is the pixel values from the Red band. In calculating the NDVI using Landsat 5 TM imagery the equation applied is ; $NDVI = ([Band\ 4] - [Band\ 3]) / ([Band\ 4] + [Band\ 3])$ while that of Landsat 8 OLI/ TIRS is $NDVI = ([Band\ 5] - [Band\ 4]) / ([Band\ 5] + [Band\ 4])$. Low values (0.1 and below) of NDVI correspond to barren areas of rock, sand, or snow.

NDVI make use of the green colouring matter existing on plants leaves. Chlorophyll takes in light energy at 0.65 ~L (red) and ~0.45 ~L (micron) (blue). It moderately reflects ~0.55 L. (green) and intensely reflects ~0.86 ~L (NIR). This accounts for the green colouration of most plants. According to Huang & Huang (2014), NDVI makes use of this distinctive spectral pattern of chlorophyll for visualisation, described by the difference amid determined solar reflection from a satellite band very sensitive to chlorophyll (~0.65~L) and a band in the red part of the visible spectrum (~0.65 ~L).

Values below 0.15 are not displayed in NDVI but in its place are natural colour imagery that represents barren land and excavated lands.

The study looked at the area covering the 11 Well pads aforementioned, the excavated roads for accessing these Well pads and the area that hosts the ISB at Kapese. An NDVI computation was conducted in the area of study using two multispectral satellite imagery. These are the 30 m resolution Landsat Imageries (Landsat 5 TM taken in 2006,2008, 2009, 2010, 2011 and 2012) and Landsat 8 OLI/ TIRS with 30m resolution from 2013 to 2017. Dry and rainy seasons imagery acquisition was carried out for both dry and rainy seasons guided by rainfall data from the Meteorological Department of Kenya. Analysed data got summarised and presented in two data types; continuous raster surface of land cover classification and floating point values NDVI ranging from -1 to +1. In addition, maps showing the NDVI and vegetation cover surfaces overlaid on the study area were developed to show the spatial distribution of the vegetation index. A Pearson linear correlation to show the correlation of the NDVI with the excavations work taking place in the study area over time was done and the strength of correlation determined. Paired T-test was used to test the hypothesis on the significant change of the NDVI of the area before and after the oil and gas exploration activities began. Regression analysis on how NDVI value varied with bareland change was in addition determined.

3.10.2.2 Atomic Absorption Spectrophotometer (AAS) in Water Sample Analysis

The analysis of the water samples heavy metal component was done in a laboratory set up as shown on appendix 7.10. Drilling fluids have got high levels of hydrocarbons content and heavy metals (Abdel-Shafy&Mansour,2016).The parameters analysed include,water P.H, Turbidity, total dissolved solids, selected heavy metals which

included; Copper, Nickel, lead, Manganese, Iron, Calcium and Potassium. The selected heavy metals in the water samples mostly associated with Barium Sulphate used as a weighting agent of the drilling fluids were analysed using Atomic Absorption Spectrophotometry (AAS). Atomic Absorption Spectrometer's functioning principle is founded on the sample aspiration into the radiation and atomised when the AAS's light beam get focused through the flame into the monochromator, and onto the detector that determines the amount of light taken in by the atomised portion in the flame. Different metals absorb different wavelengths. A source lamp made of that element is used, making the method moderately free from spectral or radiation intrusions. The level of energy of the typical wavelength absorbed in the flame is relational to the concentration of the element in the sample. The analysis got carried out in line with WHO (1997) guidelines. The samples preparation followed the WHO guidelines by carefully mixing them. The instruments used in sample preparations were: 500 μ L automatic pipette (1), 5.0 mL pipet, (1) 100 mL volumetric flask, (1) 1000 mL volumetric flask, (1) 500 mL beakers, (7) 250 mL beakers of the five dry beakers, 250 mL of deionised water was added. Using the 500 μ L automatic pipette of 0.0, 0.5, 1.0, 1.5, and 2.0 mL of each of the elements discussed below was added to each of the beakers and mixed thoroughly.

The concentrations of these elements in these standards were calculated. The flames were set up in the atomic spectrophotometer as described per every element and every sample was analysed. The lead was analysed at a wavelength of 283.3 nm by Atomic Absorption Spectrophotometry with the aspiration of the sample into the oxidising air-acetylene flame. When the aqueous sample is aspirated, the sensitivity for 1% absorption is 0.5 mg/L, and the detection limit is 0.05 mg/L. Standard lead solution: 1.598g of lead nitrate is dissolved in about 200ml of water containing 1.5ml of

concentrated Nitric acid and diluted to 1000ml of metal-free water to give 1ml = 1mg Lead. Copper was detected at a wavelength of 324.7 nm by AAS with the aspiration of the sample acetylene flame. When the aqueous solution (sample) is aspirated, the sensitivity for 1% absorption is 0.1 mg/L, and the detection limit is 0.01 mg/L. Standard copper solution 1g of copper salt was dissolved in 15ml of 1+1 nitric acid and diluted to 1000ml to give 1ml = 1mg copper. As for the Nickel, 1.273g of nickel oxide was dissolved in a minimum quantity of 10% HCl and diluted to 1000ml with distilled water to give 1ml = 1mg of nickel. A sequence of values ranging from 1mg to 5mg is formulated from the stock and analysed.

Iron got assessed by preparing a standard solution for Iron, 0.100g $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ which was measured and transferred into a 500-mL volumetric flask. 10ml of 2M, H_2SO_4 and 50-mL of deionised water was added to dissolve the compound completely, and the flask got filled to the mark with deionised water. Iron best detected at Acetylene-air frame of wavelength 248.3 nm of the AAS. Calcium was assessed by preparing a stock solution for Calcium 0.252g of dry primary standard Calcium Carbonate. CaCO_3 got weighed and rinsed into a 100 mL volumetric flask with a few millilitres of deionised water. The stock was then dissolved in 6 m HCl and diluted to the mark with deionised water. The optimum range concentration of 0.2-7 mg/l got assessed at a wavelength of 422.7 nm. Potassium was analysed by preparing a stock solution by dissolving 0.1907g of KCl (analytical reagent in deionised distilled water and filled up to 1 litre. Dilutions as aforementioned above got prepared and used in the calibrations during analysis.

The optimum concentration range of Potassium 0.1-2mg/l got detected at 766.5nm. Finally, on heavy metals, Manganese was analysed by preparing the Manganese reference solution, where 2.748 g of Manganese Sulphate was dissolved in 1000 ml

volumetric flask in water. 5 ml of hydrochloric acid got added and filled up to the mark with water. The optimum concentration range of 0.003-1 mg/l detected at a wavelength of 285.2nm Acetylene-air flame. The standard stock solution of Magnesium which had 5ml of Nitric acid and 50ml of Caesam Lanthanum added into it was prepared. It was then aspirated together with the sample at the wavelength of 279.5nm on Air-acetylene flame. In detection of Barium, a standard stock solution of Barium which had 1ml of Nitric acid and 10ml of Caesam Lanthanum added into it was prepared. It was then aspirated together with the sample at the wavelength of 553.6nm on Nitrous-oxide-acetylene flame. Other physical properties of water such as; Turbidity, Total dissolved solids, and pH were also determined. The pH and the Turbidity were established in the field using the pH. Metre and Turbido-meter respectively. The pH determination entailed the measuring of the Electro-Motive Force (E.M.F) of a cell involving an indicator electrode dipped in the test solution and the reference electrode which mostly is made up of mercury.

The interaction between the test solution and the reference electrode is usually gotten using a liquid junction, which forms a part of the reference electrode. E.M.F of this cell was determined by pH meter, that is, a high impedance voltmeter calibrated regarding pH. The electrode is allowed to stand for 2 minutes in a 1 Litre water sample in a beaker to stabilise before taking reading for reproducible results (at least ± 0.1 units). The readings got read in the field according to the WHO guidelines (WHO, 2002). The water Turbidity was also determined in the field using the nephelometer. The nephelometer was standardised using distilled water (Zero NTU) and a standard Turbidity suspension of 40NTU. The carefully shaken sample got placed in the nephelometric tube, and the value documented. $\text{Turbidity (NTU)} = (\text{Nephelometer readings}) (\text{Dilution factor})$. As for the Total Dissolved Solids, it was determined by filtering 1000 ml of the water

samples through a glass fibre filter disk. The filtrate got collected in an already weighed evaporating dish. The water samples were then evaporated until they dried up at 104⁰ C and then put in an oven at 180⁰ C. The weight of both the residue and the dish were determined, and the residue mass determined by the equation

$$; \text{MgTDS/L} = \frac{\text{Weight final(g)} - \text{Weight initialn(g)}}{\text{Sample volume (ml)}}$$

Descriptive statistics were used to analyse by calculating and presenting parameters averages in a table. The baseline information of the four communities boreholes in the study area, on the levels of physical-chemical parameters and selected heavy metals obtained from WRA, was compared with the results from the analysed samples. The results were also compared with WHO(2011) and USEPA internationally acceptable standards for selected heavy metals level in drinking water.

3.10.2.3 Archival Secondary Soil Data Analysis

The study made use of the secondary data of a soil assessment report done by SGS in July 2017 from Twiga 1 well pad whose results are shown in appendix 7.11

3.10.2.4 X-Ray Florescence Technique in Analysis of Heavy Metals of Drill Cuttings

The analysis of selected heavy metals was done using the X-Ray Fluorescence technique in the Ministry of Mining, Mines and Geological Department Laboratory of Kenya by the use of the XRF modern scanning machine. The heavy metals that were analysed were Nickel, Copper, Lead, Iron Barium, Chromium, Calcium, Potassium Cadmium and Manganese. The drill cutting samples from Twiga 1 reserve pit were dried to remove the adulterating effect of moisture by using a small field oven. The dried samples were then screened with a 2 mm mesh to remove large objects. The

samples were then ground to enhance homogenisation and sieved to ensure precise drill cuttings particle size of less than 0.250 mm. They were then homogenised well, and then sub-sampled 3 to 5 grams of the dry, well-ground drill cuttings and placed in an X-ray fluorescence sample cup for analysis. The XRF cup ensured accurate drill cuttings sample presentation on the XRF machine. The analysis results assessed against the recommended standards by international bodies such as; WHO, FEPA and USEPA. The standard deviation of the average individual elements from every layer of the reserve pit sampled was determined from the mean of the same element in the entire reserve pit as shown in table 4.4

3.10.2.5 Air, Noise, Light and Dust Pollution Data Analysis

The component of the oil activities effects on atmosphere was looked at by graphically presenting the secondary data gotten from the Kenya Meteorological Department on temperature changes since 1990. Temperature range difference across the years before and after oil and gas exploration activities began was determined. People's responses in regard to the light, dust, noise and air pollution were analysed using frequencies and presented in in percentages. Photography was used to show the light pollution and gas flaring activities in the study area

3.10.3 Descriptive and Inferential Statistics in Analysis of Oil and Gas Exploration Effects on Socio-Economic Characteristics

The collected data got coded and computed using SPSS version 20.0-computer software and excel. Both descriptive that is, the mean and the mode were used together with inferential statistics specifically Paired t- test statistics and Pearson coefficient linear correlation to analyse the data. Frequency graphs and percentages were used in the

analysis of the income and the number of conflicts cases reported. The hypothesis was tested by use of paired t-test. Data on health issue was analysed using frequency tables, percentages, and Pearson linear correlation. Data on social and physical infrastructures such as education facilities, water provisions, health facilities, security and transport and road network establishment pre and post oil and gas exploration were analysed using frequencies and percentages. The level of agreement of the respondents over these physical and social infrastructures and hypothesis were tested by use of Cohen kappa coefficient test. Data on the effects of oil and gas exploration on the local communities land such as land displacement leading to disputes due to poor locals engagement, interference with animal migration routes and compensation, effects on locals culture, loss of land and livelihoods got analysed by use of frequencies and percentages and the level of reliability was tested using Cronbach's Alpha. Sources of income, economic status, HIV prevalence due to population influx, employment were all analysed using frequencies graphs and expressed using percentages.

Pearson linear correlation was used to show the relationship of new HIV cases with time and the direction of the linear correlation. Tables, linear graphs and scatter plot got used in data presentation. Use of aerial photographs showed the other qualitative data such as the expansion of Lokichar town before and after the oil and gas exploration activities began, use of maps and photographs also showed the effects on infrastructure and provision of services by the oil companies and the governments. Data on displacement and compensation, livestock, the new business established in the areas were analysed by a quick impressionist summary, which involved summarising key findings, explanation interpretation, and conclusion.

3.10.4 Paired T-Test, Chi-Square and Cohen Kappa Coefficient Test in Hypothesis Testing

Hypothesis on the revenues of the business communities, number of conflicts cases and NDVI before and after were analysed and tested by use of a Paired t-test statistics. The hypothesis on the income of the locals pre and post commencement of oil and gas exploration was tested using chi-square test. Cohen kappa coefficient test was used in testing the agreement of the locals' attitudes on the establishment of social and physical infrastructures pre and post oil and gas exploration commencement.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

The arrangement of the results section is in the order of the objectives. The first objective entailed a review of constitutional, policy, legal and institutional framework on environmental management in the backdrop of oil and gas exploration sector in Kenya. This review was done in reference to the Kenya Constitution 2010, IFC performance standards and other best practices in oil and gas exploration and environmental management globally. Assessment of the environmental management practices in Oil Block 13T South Lokichar Basin was carried out in reference to their conformity to the Kenyan environmental law, best practices globally and IFC sustainability oil and gas exploration and environmental sustainability indicators in objective number two and three. Objective number two entailed an assessment of the effects of the oil and gas exploration activities on the biophysical environment and how sustainable are the management practices being carried out. The third objective involved an evaluation of the effects of oil and gas exploration on the socio-economic wellbeing of the communities around the oil fields since Tullow BV Kenya Ltd started the oil and gas exploration work in 2012. The study under this objective endeavoured to assess how sustainable the management strategies are for the oil and gas exploration effects on socio-economic environment in Oil Block 13T South Lokichar Basin.

The study made use of both primary and secondary data collected through observation, one on one interviews with the local communities, County administrators, Oil Company officials, National Governmental administrators, Headteachers and community leaders. Other sources of primary data included observation, photography,

mapping of the coordinates and video recording, documents review, Landsat satellite imageries, and videotaped references were the principal sources of the secondary data.

4.2 Constitutional ,Policy,Legal and Institutional framework on Oil and Gas Exploration Sector in Kenya

4.2.1 Existing Local Environmental Policies and Management Practices in Oil and Gas Exploration Sector,Relative to Constitution of Kenya 2010 and IFC Environmental Sustainability Indicators.

The study reviewed the existing environmental policies to find out whether they were responsive to the oil and gas exploration issues.The review focused on policy formulation and implementation, organisations and institutions involved in monitoring and evaluation of the environmental activities taking place in the oil and gas exploration fields. The study identified several gaps in the formulation, implementation, monitoring and evaluation of several environmental policies in Kenya.Even though Kenya has a very robust National Environmental Policy 2013,which is in line with Kenya's Constitution 2010, the study established that full implementation was a significant challenge.

4.2.1.1 National Environment Policy 2013

The National environment policy 2013 Chapter 4,Article 1 and 4,Article 6 and Chapter 5,Article 6 requires the government and the partnering investors to do public participation and proper community engagement. This is in line with Article 69(1d) of the Kenya's Constitution 2010 that requires the state to ensure public participation in the management, protection, and conservation of the environment.Article 63(1d) recognises a community land and describes it as land managed or used by particular

communities as a community, grazing area or shrines, ancestral lands, forests and lands customarily occupied by hunters and gatherers. Article 35(1a and b) in the Constitution stipulates that every citizen has a right to access of information, freedom of expression, social security. Article 22(1) stipulates that every person has the right to go to court if their rights are infringed and gives the courts to declare laws and activities unacceptable if they encroach on the citizens' rights. In addition, Kenya is a signatory to several conventions appertaining to human rights. Key among them is the Agreement on Economic, Social and Cultural Rights; Gender equality and the African Charter on human and people's right (Banjul charter). The Institute for human rights has developed the 'Nairobi processes (an accord for responsible business) in conjunction with the Kenya National Commission for human rights to integrate human rights considerations in the oil and gas sector which is a new venture in Kenya. The pact brings together the various exploring and mining companies and works with them to affirm their application of best practices, such as the UN guiding principles and other internationally recognised principles on human rights and business development. These constitutional requirements are in line with IFC performance standard number 7 that requires a free, prior informed consent from the communities before oil and gas exploration activities kick off.

The study established that 72% of the locals were not engaged in acquiring the lands for the construction of the Well pads and the access roads by the oil companies as elaborated in section 4.4.15. Chapter 6.7 of the Environmental Policy 2013 calls for the state to integrate fight against HIV/AIDs in environmental protection programs. The study noted a strong linear correlation of the rate of new HIV cases with time since 2012 in the study area contrary to the trend in the neighbouring Samburu County and other Sub-counties of Turkana County as shown in section 4.4.10. The study established

that, no unique program to integrate the fight against HIV/AIDs both at the County and the National Government level had put in place to manage the pandemic. Regarding other environmental diseases associated with oil and gas exploration activities, pollution as noted in Chapter 6.8 of the National Environmental Policy, the study established that there lacked an initiative by both the County Government and the National Government to ensure quality drinking water or safe air for the locals living around the oil and gas exploration fields. This is because both NEMA and WRA did not have any data on water and air quality and they lamented that they lacked resources and capacity in the region to do the periodic water and air monitoring. This leaves the communities vulnerable to the effects of both air and water pollution resulting from oil and gas exploration activities.

The chapter calls for the government to promote continuous research and monitoring on the effects of various developmental projects on peoples' health, an aspect that was found lacking by this study. Regarding noise pollution, the National Environmental Policy 2013, chapter 6.6 requires the Government to strengthen the capacity and infrastructures to monitor, enforce and regulate noise pollution. This is in line with EMCA (Noise and Excessive Vibration Control) Regulation 2009. The study observes that 10% of the respondents in the study area complained of noise pollution that was emanating from oil and gas exploration activities. Chapter 4, article 1 and article 10 require sustainable ecosystems management and conservation of habitats which is in line with Article 69(1a) of the Kenya's Constitution 2010, EMCA (Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit Sharing) 2006 and Environmental (Impact Assessment and Audit) Regulation 2003 that calls for land restoration after project decommissioning. It is also in line with the Cartagena Protocol which Kenya is a signatory to. The study noted that the Oil companies were

using vertical exploratory and appraisal wells drilling and this had left a lot of ecological footprints in the study area and the abandoned dry Wells had not been restored as discussed in section 4.3.1.3. The observations contravened the IFC performance standard (PS6) of biodiversity conservation on oil and gas exploration and environmental sustainability despite the assertion by the main oil exploring company that they were conforming to the IFC environmental sustainability indicators. Failure to restore the land had negative effects to both the wildlife and livestock for the pastoral communities.

Chapter 6.3 and 6.5 require the state to promote proper waste and hazardous material management facilities which is in line with EMCA (Waste Management) Regulation 2006 and Kenya's Constitution 2010, Article 42 on the right to clean and healthy environment. The study established that incineration was the only legalised method in Kenya in managing hazardous drill cuttings and as noted in section 4.3.2, incineration facilities existed a distance of 650 kilometres from the point of generation. This distance was a major hindrance to sustainable management of the waste materials due to the risk involved in transportation such as spillage and the long hours taken by the trucks during transportation. Establishment of waste management facilities in the study area is critical. The lead agencies majorly NEMA, WRA and DOSHS need to enforce the environment management guideline policy in Oil Block 13T South Lokichar Basin which shall be in line with the Kenya's Constitution 2010, IFC performance standards and other best practices globally.

4.2.1.2 The National Energy and Petroleum Policy 2015

The policy gives a structure for the provision of sustainable, reliable and secure energy while protecting the environment. Critical objectives under this policy include

provisions of maintainable eminence energy services for growth; use energy as an instrument to fast-track economic empowerment for rural and urban development, encourage growth of native energy resources, encourage energy effectiveness and management as well as vigilant environmental and safety practices. The Extractive Industries Transparency Initiative (EITI) is another strategy stipulated in the policy. This study observes that chapter 6.2.1.2 of the policy points out that the upstream oil segment causes environmental degradation and rehabilitation needs to be instantly carried out upon decommissioning of an exploration project. However as noted in section 4.3.1.3, the dry wells encountered in 2015 were yet to be restored by December 2017 as shown in plate 4.9. The study also observes that the policy does not address the management of the hazardous waste materials in the upstream oil segment such as drill cuttings. There is therefore a need for the lead agencies to enforce the implementation of the policy guidelines and review it to address issues such as generated waste materials by the oil and gas exploration process.

4.2.1.3 National Land Policy 2016

The study observed that the policy requires public participation in acquisition of the community land by the state or any agency. This is in line with Kenya's Constitution 2010 Article 69(1d) that calls for the state to ensure public participation in land and environmental management. It is also in line with IFC standard performance (PS)1 on oil and gas exploration and environmental sustainability. However as noted in section 4.4.13, figure 4.36, 72% of the locals revealed to this study that they were never consulted by the Government during the acquisition and the licensing of the oil blocks. In addition they were never consulted by the Oil companies when constructing the Well pads and access roads in their community grazing lands. There is a need for

the Government agencies to enforce the National Land Policy 2016 in the consequential land acquisition processes and especially during the crude oil pipeline construction project from Lokichar to Lamu.

4.2.1.4. National Forest Policy 2014

There is no gazetted forest in Turkana County (CGT,2017).The predominant vegetation is the dry land forest which according to the National Forest Policy 2014 needs to be well managed for sustainability of forage for the grazing communities in dry land areas.This is in line with the National Policy for Northern Kenya and other Arid Lands .The guiding policies are in conformity with Constitution of Kenya 2010 Article 69(1e) on conservation of indigenous genetic resources.However the study observed that the construction of Well pads and access roads was immensely affecting the vegetation as noted in section 4.3.The study also observed that 24% of the locals pointed out that vegetation degradation was the major environmental effects resulting from oil and gas exploration activities.As noted in section 4.3.1.3, restoration of the dry wells had not been carried out by the oil exploring companies and this calls for enforcement of the National Forest Policy 2014 by the Government agencies majorly NEMA.Technologies such as horizontal drilling discussed in section 4.3.1.3 need to be adopted to reduce ecological footprint of oil and gas exploration activities since the sedimentary rock formation of the area can allow the usage of technology.

4.2.2 Environmental Legislation Framework in Kenya

4.2.2.1 The Constitution of Kenya 2010

Kenya's Constitution 2010 provides the national governance structure since it is the supreme law of the land. It offers the bases for significant legislative changes, even the

ones related to environmental conservation and protection, land tenure, benefit sharing, citizen participation, transparency and access to information which are very crucial to oil and gas exploration and development. The Kenya's Constitution 2010 resulted in significant reforms including ,the devolved government system with equitable sharing of the resources between the County and National Government(Article 202),gender equality,(Article 59),introduction of fund to take care of the marginalised communities(Article 204),right to clean and healthy environment(Article 42(1)),right to clean and quality water(Article 43(1)),right to environmental conservation and public participation (Article 69) and access to information among the members of the public(Article 19).However,the Constitution acknowledges in Article 72 that existing legislation with reverence to warranting environmental safeguards is inadequate and that additional legislations will be essential to effect its provisions satisfactorily. As noted in the guiding policies on energy and petroleum, environment,forest,community land in section 4.2.1.1, 4.2.1.2, 4.2.1.3 and 4.2.1.4 above, the major challenges facing management of the environment in oil and gas exploration fields in Oil Block 13T South Lokichar Basin is lack of enforcement of the laws by the relevant agencies since these policies have been aligned to the Kenya's Constitution 2010. There is a need however to develop some more specific environmental management legislations as noted in Article 72 of Kenya's Constitution 2010 that are related to oil and gas exploration and production.

4.2.2.2 Petroleum Act 2019

In review of the Act, the study observed that the country has agreed on the predicaments in the oil sector specifically the capital intensiveness and the technical intricacy of the industry.Section 9 of the Act, states that the Government will endeavor to build a

favourable environment for investments in oil and gas exploration and production sector. This will entail infrastructure development such as roads and electricity connectivity as it is doing in Lokichar area, formulation of strategies for upstream segment development, in association with appropriate Government agencies and disseminate them among possible investors.

However, the section is silent on the devolved government agencies and even the creation of the same towards the promotion of the investment. This is even, though these exploration activities are being done in the counties where the reserves exist. Another challenge with the Act is the fact that it only points out to the role of the National Government in enhancing and facilitating the acquisition of exploration of land without acknowledging the significant role of the County Government. However much of the subsoil rights remain with the State on behalf of the people as specified in the Kenya's Constitution 2010 Article 62(2) and section 41 of the Act, the subsurface privileges on the other hand both public and private, are for the County Government and the local communities and hence they ought to be consulted during land acquisition. Though the County Government seemed to be slightly engaged, interviews with the locals revealed that 72% of them were not engaged at all. They disclosed to this study that only the local politicians and a few local elites were engaged. The findings are consistent with Akujuru (2014) who noted the same divide and rule tactic being used by the oil explorers in Niger Delta

Another issue that the Act speaks into is the local content training. The Act describes local content to mean the auxiliary value gotten by Kenyan economy from activities associated with oil and gas, through methodical expansion of national capability and investment in developing and sourcing for the available indigenous workforce, supplies and services for the distribution of accumulating benefits. Section 77-79 of the Act,

emphasises on the prerequisite for an investor to consider first the services and goods provided and produced in Kenya if they are meeting the petroleum industry specifications and standards as required by Kenya Bureau of Standards or any other acceptable international standard. The Act also requires that skilled Kenyans are given priority for employment at all levels of the value chain. According to the Act, it is evident that the government has taken the national content instead of the community content aspect, and therefore no immediate need for an investor to make use of goods and services from the local communities affected by oil and gas exploration activities. The Act must be reviewed because in its current form, the investors will not have the local communities consent, this may trigger conflicts related to employment, and tender services award to the locals as shown in the figure 4.40. The government needs to evaluate its local content Act against that of Tanzanian counterpart, which is successful at regional and local level. Tanzania LC requires an investor to incorporate personnel, goods, and services from the local community and regional perspective. In this Act, an investor is expected to submit short and long-term plans subject to approval by the Petroleum Authority yet to be formed. The plans should address issues such as research and development, technology transfer, employment and training industrial attachment and apprenticeship, legal services, financial services and succession plans for positions held by foreigners in the Oil companies.

The Act also mentions that the cost of the local content should be lower than that of any other area. This would be very hard to execute since many manufacturing industries in Kenya are still at an infant stage. Realising certain levels of labour, goods and services may not suffice with the country's limited industrial status, also where the local supply issue encompasses corresponding products, price does indeed become a principal issue, however, in many other examples, it may just be secondary. The primary factor would

be more about the value factor than the price. Not considering that, the Act requires that such conditions be in line with the KBS standards or universally conventional standards. Since the country is yet to develop the sector, it is clear that the standards being expected are not yet in place. This sort provides an opportunity for an investor to evade the law (creative compliance) and utilise the opportunity to opt for international standards, which will give preference to foreign goods as opposed to local goods hence nullifying the objective of the local content.

The Government in its 2016 Energy and Petroleum Policy admits that there is inadequacy of expertise within the sector and an initiation for training of nationals on these skills to take up the jobs in the industry in latter days. The training is being locally done by use of funds set aside from the training kit. The Act is not apparent the party to undertake the training whether it is the Government or the investor. Sections 80-85 covers the generated revenues from oil activities. To an investor, compliance with financial and fiscal obligations is imperative. The Government will be expecting revenues to be emanating from royalties, bonuses, taxes, fees and levies as may be prescribed in the petroleum agreement. Where a contractor fails to do so, there will be extended legal ramifications as will be detailed in the petroleum agreement.

On revenue sharing the bill proposes the sharing of the profits in the ratio of 75:20:5. That is 75% to go to the National Government, 25% to go to the County Government and 5% to go to the local communities. However, the Act does not elaborate in which form the 5% allocation that goes to the communities will be given out whether in terms of social and physical infrastructures or hand cash. The study observed that the locals' expectations were that they would receive the 5% in terms of cash which would introduce the problem of its sharing in the county. This is because everyone would claim a share even those who are not from Oil Block 13T South Lokichar Basin, but

the oil shall be tracked through their land. The Act is not also clear if the sharing will be done after the cost recovery or is it the profit share. Some oil blocks have been discovered to extend in more than one county like Oil Block 13T South Lokichar Basin which extends in West Pokot, Baringo and Turkana Counties. The Act is silent on how the 20% will be shared in case of a transboundary oil reservoir among the counties hence the need for the amendment of this legislation.

4.2.2.3 The Prevention, Protection and Assistance to Internally Displaced Persons and Affected Communities Act of 2012

The Constitution categorises all water bodies such as lakes, rivers and wetlands under Article 62 as public lands. The Prevention, Protection and Assistance to Internally Displaced Persons and Affected Communities Act of 2012, address the challenge of relocation and displacement due to development projects such as oil and gas exploration. The Act states that displacement and relocation caused by such projects shall be legal if vindicated by compelling and dominant public interests and in harmony with this Act. This study established that this Act was contravened since 72% of the locals were not consulted when they were displaced from their communities land in the study area.

4.2.2.4 Land Act 2012

In a review of the Land Act (2012), the study noted that the Commission of Lands facilitates the process for compulsory acquisition of land, formed under the National Land Commission Act 2012 and it states that the compensation of the land should be done before the possession is carried out. The commission is expected to publish regulations on fair compensation to the affected. Section 111 of the Act requires the

full compensation to be done promptly after the acquisition of the land. This has not happened in Oil Block 13T South Lokichar Basin in Turkana since a survey conducted with the locals revealed that majority of the displaced people from their community grazing lands had not been compensated and this had resulted to community land compensation related conflicts as noted in figure 4.40.

4.2.2.5 Environmental Management and Coordination Act (CAP 387)

This Act is the principle environmental legislation in Kenya. Several subsidiary legislations have been developed to operationalise the Act including regulations relating to Water Quality, Fossil Fuel Emission Control, Noise and Vibration, Air Quality Standards, Waste Management; Controlled Substances and Conservation of Biological Diversity. EMCA CAP. 387 establishes a legal and institutional framework that ensures management of the environment and issues related to it such as environmental protection, policy, planning, environmental inspection environmental impact and audit and environmental conflict resolution. Part VIII sets down requirements relating to environmental quality standards as well as water and air quality, waste management in (sections 70, 71, 78, 86).

4.2.2.5.1 The Environmental (Impact Assessment and Audit) Regulations, 2003

The regulation requires public participation to be conducted to ensure integration of public participation in making decisions on a project that may affect the environment before any project commences. 72% of the locals in the study area lamented that very few individuals had been consulted and engaged in decision making for Well pads development and access roads construction. Even though the law requires land restoration, a dry well is encountered; the study established that four dry wells had been encountered, but restoration had not been carried out. According to the EPA

regulation, dry wells should be restored nine months after the date of encounter (Elkin, 2012). Emong, Ekoswan, Etiir and Cheptuket wells were completed in more than nine months ago with Emong and Ekoswan having been completed in 2015, yet restoration had not been carried out by January 2018. There was no audit report data from WRA and NEMA on water, soil and air quality from the surrounding ecosystems as required by the Kenyan environmental laws an indication of poor enforcement by the agencies and non compliance to the law.

4.2.2.5.2 The Environmental Management and Coordination (Deposit Bonds) Regulations 2014

The regulation applies to oil and gas exploration activities, and it demands that Bond Assessment report is handed in as part of EIA. In their current nature, the guidelines would necessitate the terms of reference for the report to be agreed in advance with NEMA. The report should also include, “a restoration, post care and upkeep plan as well as the required standards of remediation mechanisms, the activities involved, time to be taken, cost implication and the party to be held accountable, checking mechanism; the amount of deposit bond allocated, and details of the operator/proponent answerable for effective remediation works”. According to the regulation, NEMA has powers to raise or withhold all or part of the bond.

4.2.2.5.3 Environmental Management and Coordination (Water Quality) Regulations 2006

A review of the regulation of 1999 indicated that the development and management of water, that includes the underground water, rivers, lakes and wetlands are guided by this regulation. Water should be considered in terms of quality and quantity. The Act calls

for sustainable utilisation of water resource by avoiding activities such as water pollution and degradation of catchment areas. It outlines the effluent discharge standards that are permissible into the environment, but it is silent on the standards for receiving water quality. The findings of this study as noted in section 4.3.2 demonstrate lack of compliance to this law. This is evidenced by the water contamination hazards posed by the poorly disposed drilling waste materials..

4.2.2.5.4 Environmental Management and Coordination (Waste Management) Regulations, 2006)

A review of the regulation indicated a lacuna since it provides on the management of wastes, such as industrial, radioactive and hazardous and toxic substances but there is no mention of the oil and gas sector waste materials such as drill cuttings and drilling fluids generated at the oil and gas exploration stage. The legislation recognises incineration as the technique of choice in the management of hazardous waste material but does not identify technologies such as Thermal Desorption Unit, phytoremediation and bioremediation in the management of waste such as drill cuttings. There is a need to develop more subsidiary legislations focusing on oil and gas exploration and production waste management, since incineration alone will not manage the heavy metal impurities hence the need for phytoremediation technologies.

4.2.2.5.5 The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) Control) Regulations 2009

Despite there being a regulation on noise and vibration controls, the study established that there was no periodic monitoring of the same taking place in Oil Block 13T South Lokichar Basin. The NEMA officials on the ground lamented that they lacked capacity

and resources. Moreover the oil companies did not have records of the noise monitoring in the area. This is despite the fact that 10% of the locals pinpointed noise pollution as one of the problems that have resulted from oil and gas exploration activities as noted in section 4.3.5. The Environmental Management and Coordination (Air Quality Standards) Regulations of 2008 stipulates on emission levels, but it is still in draft form and needs to be enacted into a law.

4.2.3 Institutional Framework

The study established that Kenya has a robust policy and legislation framework to ensure sustainable environmental management in the backdrop of oil and gas exploration. However, there is a need for the County Government and the National Government to enhance the implementation through the relevant agencies by allocating enough resources and capacity building of the agencies personnel. Lack of enough resources and facilities were pointed out by the local WRA and NEMA offices as the major hinderances to monitoring and evaluation of the oil and gas exploration activities effects to the surrounding ecosystems. The study noted that the nearest NEMA and WRA offices were 120 kilometers away from the oil and gas exploration fields of Oil Block 13T South Lokichar Basin with less than five members of staff each. There were no offices of DOSHS in the whole of Turkana County implying that the governments was not in a position to monitor adherence to environment health and safety measures in the oil fields. The oil companies operating in the study area have taken advantage of these challenges and failed to do their internal environmental auditing. This study established that the local CBOs and Civil Society Organisations are incapacitated since the agencies that should support them lack the capacity in monitoring and evaluation.

4.2.4 Benchmarking the Kenyan Oil and Gas Exploration and Environmental Management Regulation and Practices with the IFC Performance Standard Indicators on Oil and Gas Exploration and Environmental Sustainability

The study reviewed the existing legislative framework, the environmental management practices against the International Finance Cooperation a member of the World Bank Group guidelines and noted several gaps that needs to be addressed.

The IFC has been developing policies, guidelines, directives and performance standards to ensure that environmental and social safety measures are put in place and incorporated during planning and implementations of all the projects they do finance. This study established that the IFC financed the main oil companies operating in the study area with 50 million US dollars in 2015 and the oil companies committed to abide by their universal environmental sustainability indicators. If IFC performance standards were adopted and implemented in oil and gas exploration industry in Kenya, it would immensely contribute to achieving sustainable environmental management.

The IFC performance standard one (IFC P1) calls for the integration of social and environmental performance which should be administered from the commissioning to decommissioning of every project. It should entail active community participation and involvement by disclosing all information regarding the project openly and transparently. It underscores the need for particular attention in dealing with vulnerable and marginalised communities. The Constitution of Kenya 2010 Article 39, provides for the right to information. Article 56 provides for affirmative action programs for marginalised communities, to be allowed to participate in decision making that may affect them, and also in governance. The National Policy for the Sustainable Development of Northern Kenya and other Arid Lands 2013 also is consistent with the IFC PS 1. 72% of the people interviewed from the study area as noted in figure 4.36,

were of the opinion that they were not engaged in decision making over oil and gas exploration activities in the study area. They revealed to this study that they only saw the construction of the Well pads and access roads taking place. The study established that failure by the Government and the oil exploring companies to engage the locals resulted to the various forms of conflicts discussed in section 4.4.15.

The second IFC performance standard is on Labour and Working Conditions standards. It deals with labour and working environments. The rationale of the PS2 is to ensure proper management-worker relationship. It encourages justice among the workers and advocates for a safe and healthy work environment where measures to prevent injuries and diseases are put in place. A visit to the oil and gas exploration field in Turkana, and an observation of the worker's campsites, offices and working environment demonstrated total compliance with the strategies above. As noted in figure 4.24, majority of the 20% of the employed locals were working in the oil industries, and 70% of them felt that their economic status had moderately or adequately improved hence their lives had changed, and they appreciated their working environment.

Performance standard number three is on resource efficiency and pollution prevention. These guidelines target to prevent or reduce pollution from development activities. It explicitly encourages the reduction of emissions that lead to climate change. It also calls for sustainable utilisation of water in case a project requires a significant amount of the resource. Several regulations in Kenya are consistent with this IFC guideline. The Kenya's Constitution 2010 Article 69(1), talks of environmental protection. Article 42 calls for a clean and healthy environment. EMCA CAP. 387 which is the overarching legislation regarding environmental management stipulates on how the situation should be managed. Several subsidiary legislations have been enacted to influence the implementation of EMCA CAP. 387. Key among them are EMC

(Waste management) Regulation 2006 ,EMC(Noise and Excessive Vibration)Regulation 2009,EMC(Air Quality and Low Emissions)Regulation 2008.The Petroleum Act 2019 yet to be enacted into a law describes the management of waste materials from the oil and gas exploration and production activities to ensure a clean environment.

The National Energy and Petroleum Policy 2015 talks of a clean source of energy with vigilant safety to the environment.Other legislations and policy frameworks that if implemented should safeguard the environmental resources from pollution includes the Water Policy 2016 that prohibits any form of water pollution. However, despite the many legislations and elaborate policy framework, some gaps need to be addressed especially if sustainable biophysical environmental management is to be achieved in Oil Block 13T South Lokichar Basin.There is a need to fast-track operationalisation of the Petroleum Act 2019.The operationalisation will form an integral part of the oil and gas exploration sector legislation since it will establish specific policies for upstream, midstream and downstream segment. Institutions such as the Upstream Petroleum Regulatory Authority shall be formed that will go a long way in ensuring proper environmental management in the oil sector.There is a need also to develop EMCA CAP. 387,subsidiary legislation explicitly addressing the challenge of waste materials generated from oil upstream oil segment.The subsidiary legislation should allow the adoption of technologies such as Thermal Desorption Unit,phytoremediation and bioremediation explained in section 4.3.2,which will ensure proper drill cuttings, and drilling muds waste management.This is because as indicated there is poor management of these waste materials and they are potential water, soil, and air pollutant in the study area. The EMC (Air Quality and Low Emissions) Draft 2008,needs to be fast-tracked

into an act to ensure regulation on emissions resulting from flaring of gases as noted in plate 4.16.

Performance standard 4(PS4) is on Community Health, Safety and Security. These guidelines deal with project-related actions such as infrastructure and machinery safety, natural resource and environmental and emergency readiness and response in case of the broader community. It strives to avoid or reduce the dangers resulting from developmental activities PS4, also covers contagious diseases that may be linked to the influx of population in search of permanent or short-term jobs. The performance standard also addresses the water ecosystem issues where it requires the provision of fresh water to the communities to protect them from water-borne diseases. This guideline is in line with several local legislations such as the Kenya's Constitution 2010 Article 43(d), EMC (Water Quality) Regulation 2006, the Water Act 2016, and the Public Health Act 2017.

The study established non-compliance on monitoring and evaluation of water resource to ensure safety. The government agencies that are supposed to be doing regular monitoring of water resource due to the oil and gas exploration activities that are taking place in the area did not have the capacity to do so. Non compliance got evidenced by the fact that the most recent data on the water quality of the boreholes found in the study area was for 2012 and 2011 as shown in Table 4.5 below. The findings came amidst the public outcry of the poor management of the mud cuttings by the oil companies in South Lokichar Basin. The prevalence rate of HIV/AIDS was rising in the study area, as shown in figure 4.31 and the study attributed it to the influx of the population in the study area by the people looking for jobs as noted in figure 4.26. Although it is illegal in Kenya to infect someone intentionally with contagious diseases such as HIV (HIV and AIDS Prevention and Control Act, 2006) section 14, it would be impossible

to determine when it is done intentionally especially in cases of an agreement of the involved parties to have a love affair, and this makes it impossible for a law to control the spread of the said diseases. The study established that despite the requirement by the National Environment Policy 2013 in chapter 6.7 to the government to integrate the fight against HIV/AIDS in environmental protection programs, no initiative was identified to manage the pandemic in the area. There is a need therefore for the County Government of Turkana to develop policies that can enable allocation of more resources towards primary health care on HIV /AIDS transmission for areas experiencing oil and gas exploration activities to stem the disaster. There is also need for increased moral education from the religious communities and schools from the area to help in minimising the prevalence rate of the disease. The increasing trend of other health diseases noted by the study, that is the respiratory tract infections, the eye infections, and the skin infections as shown in table 4.9 needs to be investigated further. The study attributes the challenges dogging the oil and gas exploration sector to failure of compliance with IFC (PS4). This is due to the poor enforcement of the existing legislations and policies by the government agencies such as NEMA and WRA.

The fifth IFC Performance Standard (PS5) is on land acquisition and involuntary resettlement. It calls for adequate compensation and remunerations to evicted individuals, consultation of community members, a mechanism for handling grievances and resettlement formations and implementation to warrant appropriate displacement of people where required. The PS 5 requires shunning or reduction of uncontrolled resettlement and tries to alleviate negative socio-economic effects from land acquisition. It calls for the appropriate revelation of information, consultation and full participation of the affected people and the provision of compensation for loss of assets.

Where involuntary resettlement cannot be avoided, displacement should be reduced; compensation should be paid for lost assets, adequate replacement housing should be provided, and livelihoods and standards of living of displaced people should be restored. There are several legislations in Kenya that are consistent with this IFC environmental sustainability indicator. Examples are the Prevention Protection and Assistance to Internally Displaced Persons and Affected Communities Act of 2012, the Community Land Act 2016 and the Kenya's Constitution 2010. The Prevention Protection and Assistance to Internally Displaced Persons and Affected Communities Act of 2012 are in line with the mentioned IFC performance standard and requires that for the communities to be displaced, it has to be persuasive and should meet the public interest. The Act also requires the compensation to the displaced for the acquired land before the actual project begins. The land among the Turkana communities is a communal land and is recognised by Kenya's Constitution 2010, Article 63(1) as a land held by communities identified on the basis of ethnicity, culture or similar community of interest.

There is a need therefore to fast-track the operationalisation of the Petroleum Act 2019 to provide a basic legal framework on matters surrounding community land compensation. The study established that the local communities are very displeased by the way the Oil companies in conjunction with the National Government have been compensating them for their community grazing land. As noted in figure 4.35, 58% of the respondents said that the oil and gas exploration activities had displaced them from their community grazing lands to a great extent. An interview with the main oil exploring company officials revealed that the form of compensation they were giving were in form of social and physical infrastructures such as schools, hospitals, roads and water boreholes. The study established that the beneficiaries of such projects were

the members of the clans whose land had been acquired for drilling activities. A focused group discussion with the local elders as shown in appendix 7.9 disclosed that there were oil Well pads like Etom 1 that was constructed on the border of the land belonging to two different clans, and conflicts over who should be compensated erupted among the clans. The study noted that such cases were prevalent and were causing a lot of inter-clan conflicts in the study area as shown in figure 4.39. The locals further revealed that there were community lands that had not been compensated in any way since 2015, and a key example was the ISB 500 acres land. The land was leased by a few local politicians, and the locals felt that they were snaffled their land for the Oil companies to put up the Integrated Support Base for their operations in Oil Block 13T South Lokichar Basin. In conclusion, there is a need for the country to develop an enforcement and implementation mechanism of the existing policy and legal framework if sustainable socio-economic environmental management is to be realised in Oil Block 13T South Lokichar Basin.

The IFC Performance Standard (PS) 6 is on biodiversity conservation and sustainable management of living natural resources. It provides regulation on the prevention of adverse effects on biodiversity and ecosystem services. Any dilapidation should be alleviated with the intention of managing renewable natural resources sustainably. In trying to identify areas of high biodiversity value, the guideline has categorised biodiversity into, natural habitat and this area has no feasible option, and little loss may be experienced. The other category is critical habitat and is subject for achieving a net gain of the biodiversity. The purpose of demarcating such environment is to detect areas that would be particularly delicate to the development and to place some stringent measures on developments in these areas. The guideline requires that projects in legally protected habitats to fully engage the communities in determining ecosystem services

of preference. Kenya has several domestic legislations that are consistent with the said guideline. These include the Wildlife Conservation and Management Act 2013, EMC (Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit Sharing) Regulation Act 2006 and the Environmental (Impact Assessment and Audit) Act 2003 that requires an assessment of the environmental baseline information and the development of an environmental management plan for any project before it kicks off. Forest Conservation and Management Act 2016, and other international conventions such as Convention on Biological Diversity and Convention on International Trade of Endangered Species that Kenya is signatory to. However, the study noted several non-compliances by the oil companies operating in the study area.

By 2017 the oil explorers had encountered four dry wells and despite the requirement by the international standards such as those developed by EPA (2014) to restore dry wells within 9 months upon their being encountered. Some Well pads such as Emong shown in plate 4.9 and Ekoswan have not been restored since 2015. The study also established that the oil companies were using vertical oil well drilling technology in the study area and as a result, a lot of ecological footprints were being left behind affecting negatively the pastoral communities grazing areas. The study established that by December 2017, 280 kilometres of well pad access roads had been constructed by the oil companies, and the network was quite dense as shown in figure 4.29 and this had led to clearing of the dry forest vegetation.

According to Earthview Geoconsultants (2012), horizontal drilling of sedimentary geological rock material in the Rift Tertiary basin where Lokichar Basin is situated can allow the usage of the technology, but for the cost implication. Landscaping and restoration of the dry wells would help to safeguard the biodiversity in the study area.

The land cover of the study area had indeed changed as shown by the land use maps in plate 4.4. Areas where vegetation had been cleared did not have the fauna that had been spotted in the areas before oil and gas exploration work began and also that were seen in the areas where oil and gas exploration had not been carried out as shown in plates 4.5, 4.6, 4.7 and 4.8.

The IFC Performance Standard (PS)7 calls for the recognition of the local people; indigenous people. It avails direction on the avoidance of adverse effects on the local communities and encourages active communication. It calls for the Free Prior and Informed Consent (FPIC) from the communities in areas affected by developmental projects and areas where relocation has to take place from natural resources such as land that has traditional or customary affiliations. The Kenya's Constitution 2010 is in line with this guideline. However, a survey conducted to the locals revealed that the oil companies did not seek to fully understand the dynamics of the livestock migration routes of the local pastoral communities and this affected their nomadism way of living to a great deal. The locals argued that they are forced to use longer routes due to the protected areas around the Well pads and cross the wide Well pads access roads as shown in plate 4.8 as a result many livestock had died from the vehicle accidents.

4.3 Oil and Gas Exploration Effects on the Biophysical Environment

Figure 4.1 below, show the opinions of the locals in a survey over the effects of oil and gas exploration on the biophysical environment where (n=361) with a focus on drillwaste disposal, vegetation clearance, noise, dust, light pollution and litter

management.

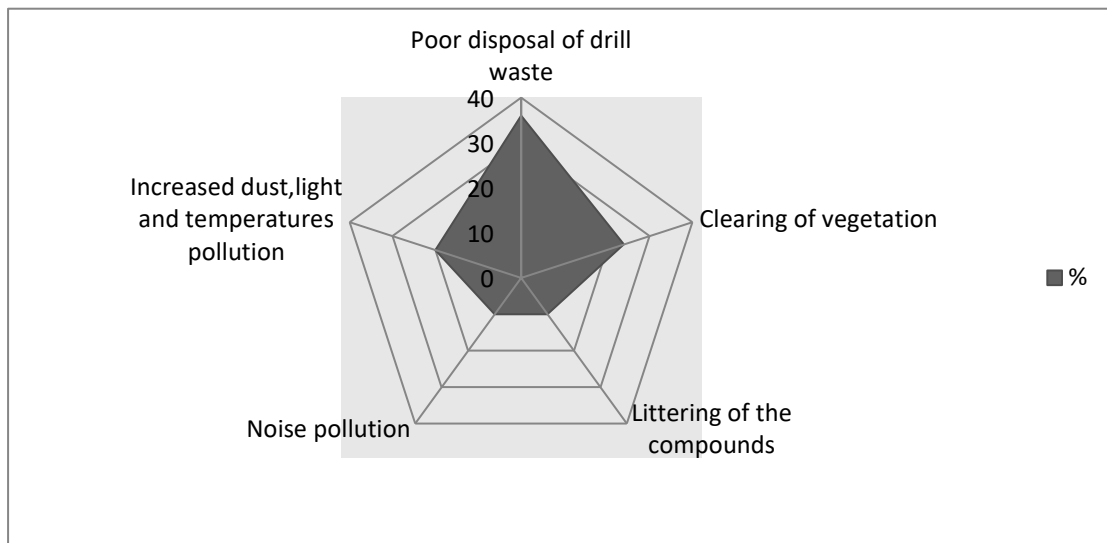


Figure 4.1: Locals opinions in percentages on the effects of oil and gas exploration on the biophysical environment (Data source: Field survey, 2017)

36% of the respondents felt that poor disposal of the drill waste material was the major challenge the oil and gas exploration activities had posed to the environment and they claimed that the waste material had polluted their community water boreholes. 24% of the respondents asserted that the major effects of the oil and gas exploration activities was clearing of the vegetation and a closer interrogation of this category established that they were mostly pastoralists whose main source of income was pastoralism. Noise pollution and the littering of the compounds with empty cans and papers were the other effects associated with oil and gas exploration activities with each having a response of 10% of all the interviewees. The noise pollution according to the respondents was from the drilling rigs in the Well pads, earthmovers and bulldozers mostly used in road construction and clearing of the Well pads. 20% of the respondents pointed out dust emission to be a major environmental impact associated with the oil and gas exploration activities. The issue of dust emission according to some respondents was due to the construction of access roads to the Well pads, and the management of dust by

sprinkling water could not yield much since water is a scarce resource in the County of Turkana.

4.3.1 Oil and Gas Exploration Effects on Vegetation Cover

A review of an environmental impact assessment report done for Oil Block 13T South Lokichar Basin indicated that the study area had a diverse vegetation cover including, dwarf shrubs, shrubs and dry forest trees. The grazing areas are dominated by *Cadaba farinosa mellifera*, *Tribulus terrestris*, *Dactyloctenium aegyptium*, *Boscia coriacea*, and *Digitaria milaniana*. Among the Dwarf shrubs includes the *condyoclada Balanites orbicularis*, *Aristida mutabilis* and *Tragus berteronianus Tetrapogon cenchriformis*, *Mollugo cerviana*, *Seteria sphacelata* and *Becium obovatum*. The shrubs found in the area includes *Enneapogon cenchroides*, *Chloris virgata*, *Aristid mutabilis*, *Acacia reficiens* and *Cordia sinensis*. The pastoral communities depends on this vegetation for their cattle as noted in plate 4.1 below.



Plate 4.1: Sheep grazing at Kapese village in Turkana South Subcounty (Photo: Researcher, 2017)

Livestock keeping is the main activity that supports livelihoods in Turkana County as noted in section 4.4.5. The study established that oil and gas exploration activities are

greatly affecting the grazing areas in Turkana County. The indigenous sources of livelihoods needs to be sustained, since employment in the oil sector especially at the exploration stage is cyclic and hence cannot be depended on. With the current trend of exploration and communities displacements noted in section 4.4.12 the communities' traditional source of livelihood may fade into oblivion as it is reported by Inomiesa (2015) over the cases of the communities dwelling around Niger Delta in Nigeria if proper measures are not put in place.

Oil Block 13T South Lokichar Basin spans to an area of 4,719 Km². A total of 38 oil wells had been drilled by December 2017 (Tullow PLC, 2018). The study through ArcGis analysis established that an area totaling to 1350 Km² had been affected within Oil Block 13T South Lokichar Basin by the 38 wells pads, the access roads to the various well sites and the Integrated Support Base (ISB) camp at Kapese where all the operations in Oil Block 13T South Lokichar Basin are coordinated. The study found out that four of the 38 wells pads drilled were dry wells and had been abandoned. According to the lead environmentalist from the main Oil Company operating in the basin, when a well is being drilled, a well campsite is normally put up and the derrick, the mud pit for drilling muds preparation, generators and all other facilities needed to support the drilling activities are normally put in place. A fence is normally erected and a buffer zone of about 1320 feet radius is normally created to keep off any human settlement or activity.

The study established that 250 kilometers earth roads had been constructed to access the Well pads as shown in figure.4.30. Plate 4.1 below shows an aerial photograph of a well pad and how they normally interrupt the vegetation cover in an area.



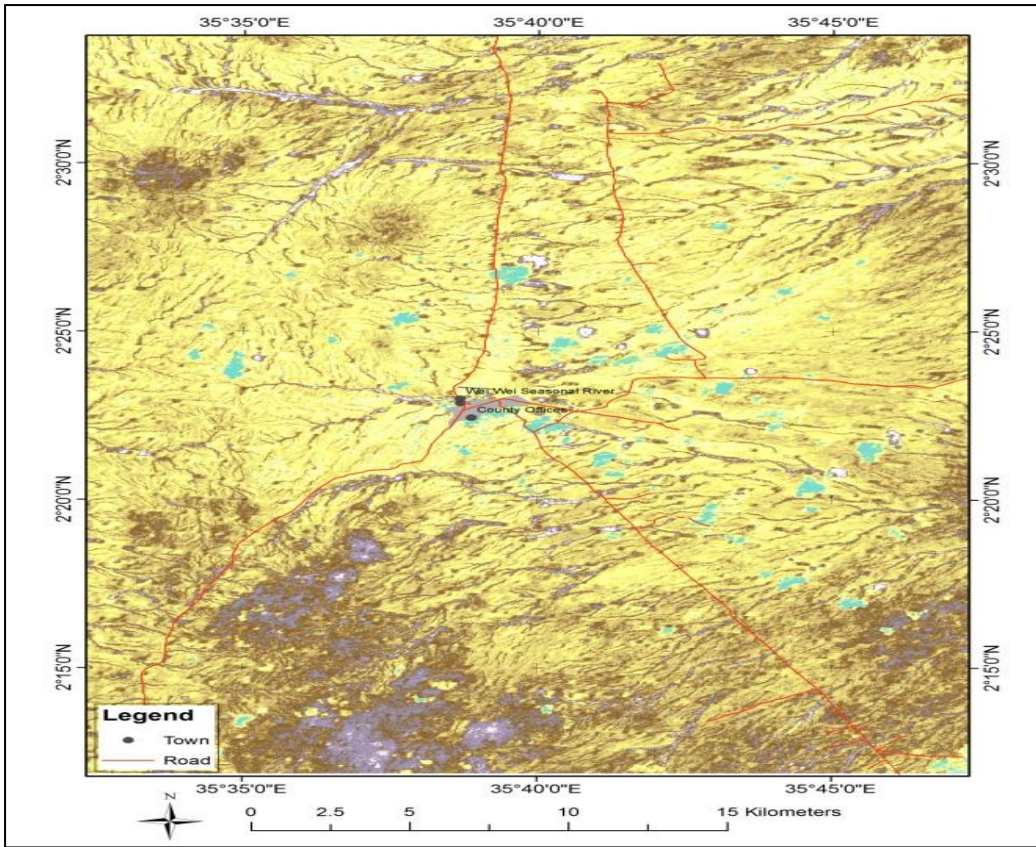
Plate 4.2:An aerial view of a well pad at Lokichar Basin (Source:Ramani engineering, 2017)

The study did a satellite land cover and NDVI imagery analysis for Oil Block 13T South Lokichar Basin before the oil and gas exploration activities began in 2012 and after for both rainy and dry seasons for the period between 2006 and 2017 and the findings were shown in Plate 4.3 and plates 4.4. Appendix 7.10, *a1 and a2* shows the landsat 5 satellite images of the study area pre to the commencement of oil and gas exploration activities in Oil Block 13T South Lokichar Basin. The images were taken for both dry and rainy seasons for year 2006. Appendix 7.12 plate *b1 and b2* shows images acquired during the dry and the rainy seasons in year 2009 and 2008 respectively. From the images, Lokichar town and a few access roads are visible as noted from the legend. Plate *c1 and c2* shows Landsat 5 images of the study area taken in 2012 and 2013 for the rainy and dry seasons respectively. Twiga1 and Ngamia1 Well pads, which were constructed in 2012 and access roads to Well pads are visible from the images

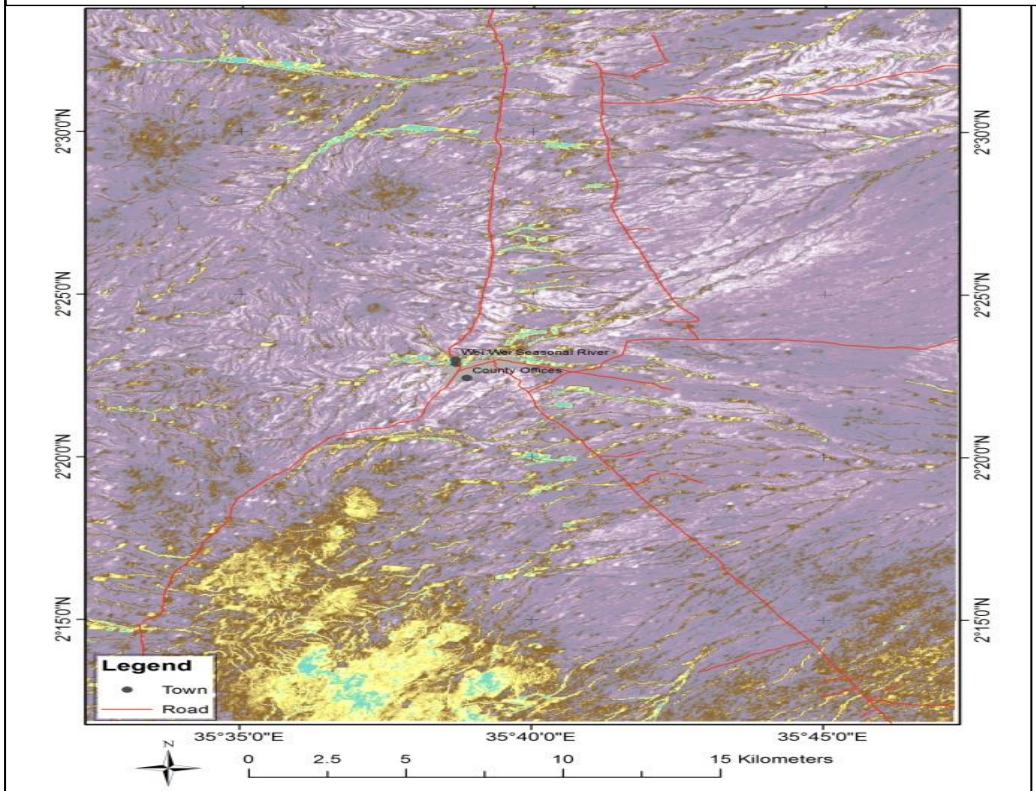
Appendix 7.12 plate *d1 and d2* shows the Landsat 8 satellite imageries of the study area for 2015. Several Well pads and access roads had been constructed. Kapese Integrated Support Base (ISB) whose total land area is 500 acres and formerly a community grazing land had also been constructed. plate *e1 and e2* shows a 2017 Landsat 8 imageries of the study area taken during the dry and rainy season. Lokichar town, the Kapese integrated support base (ISB) and Well pads constructed in the area are quite visible. The images show dense interwoven road networks interlinking the various Well pads all the wells are quite visible, the road networks, and ISB camp.

4.3.1.1 Normalised Distribution Vegetation Index (NDVI) of the Study Area

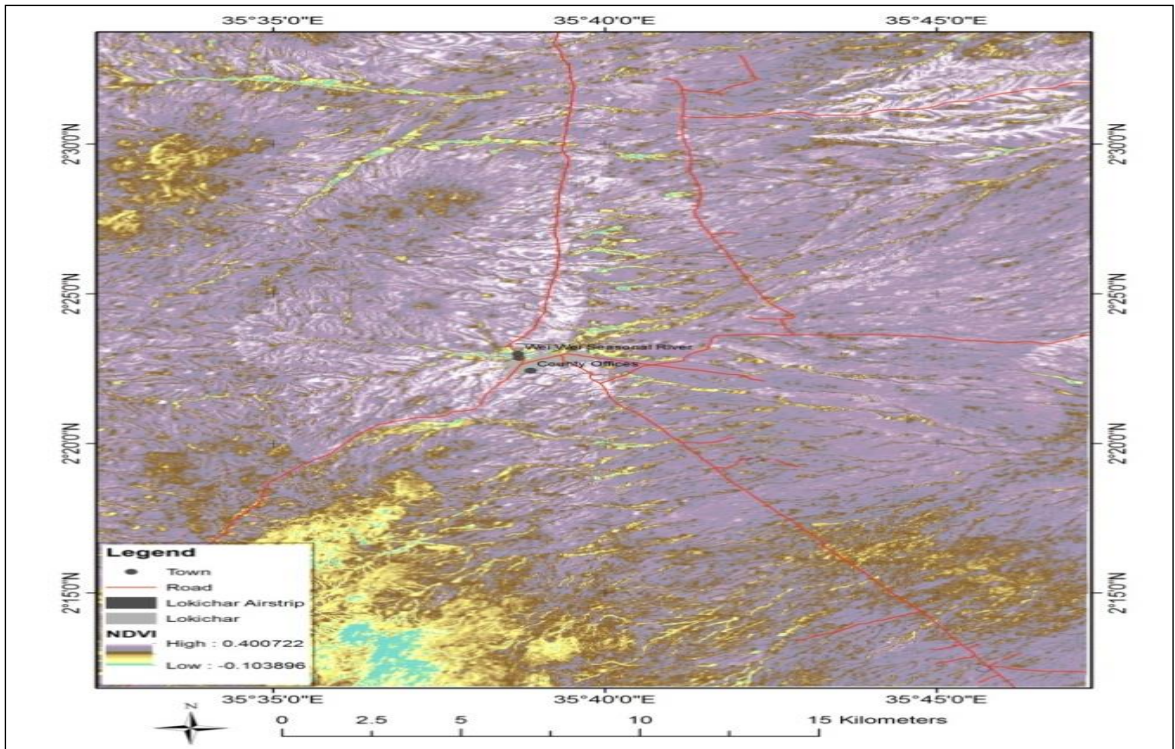
As noted in section 3.10.2, NDVI depicts the density of green vegetation on a patch of land. The study did an analysis of the NDVI values of the years 2006, 2008 and 2009 for the dry and rainy season before oil and gas exploration activities began in Oil Block 13T South Lokichar Basin. This was compared with the NDVI values of the study area after the commencement of oil and gas exploration for the years 2012, 2013, 2015 and 2017. The NDVI values were calculated and shown in the NDVI maps in Plate 4.3 (*f1; f2 g1; g2, h1; h2, i1; i2, j1; j2, k1; k2, l1; l2, m1; m2*)



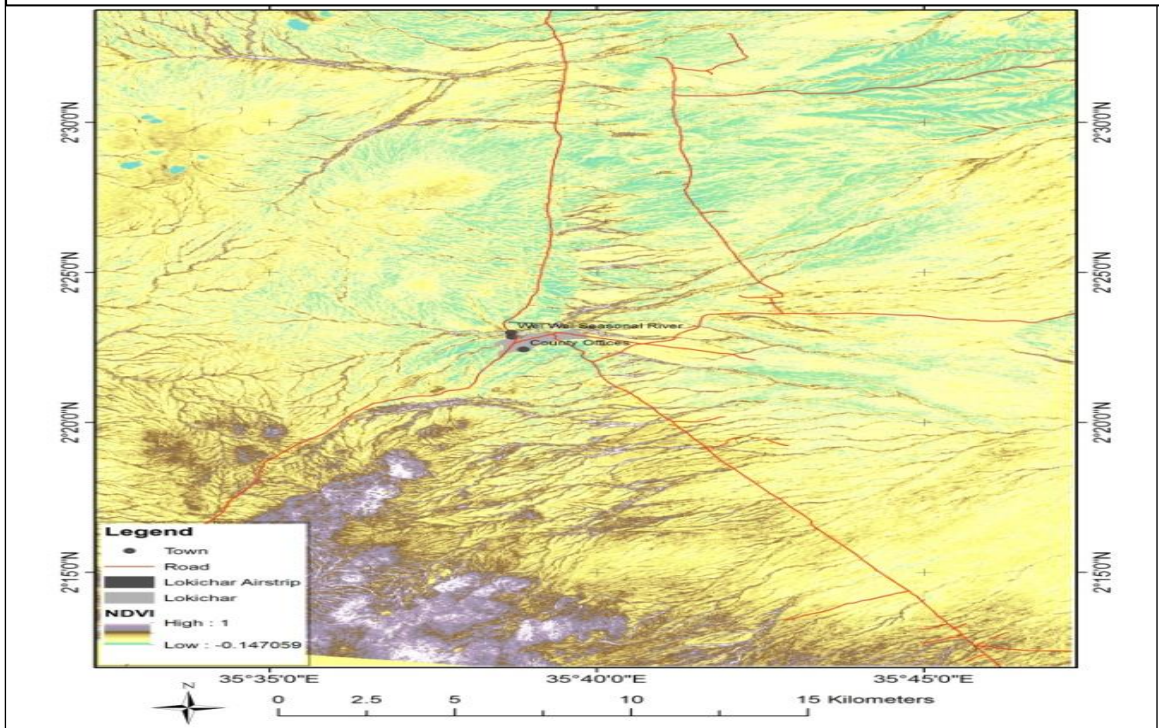
f1 dry season NDVI 2006



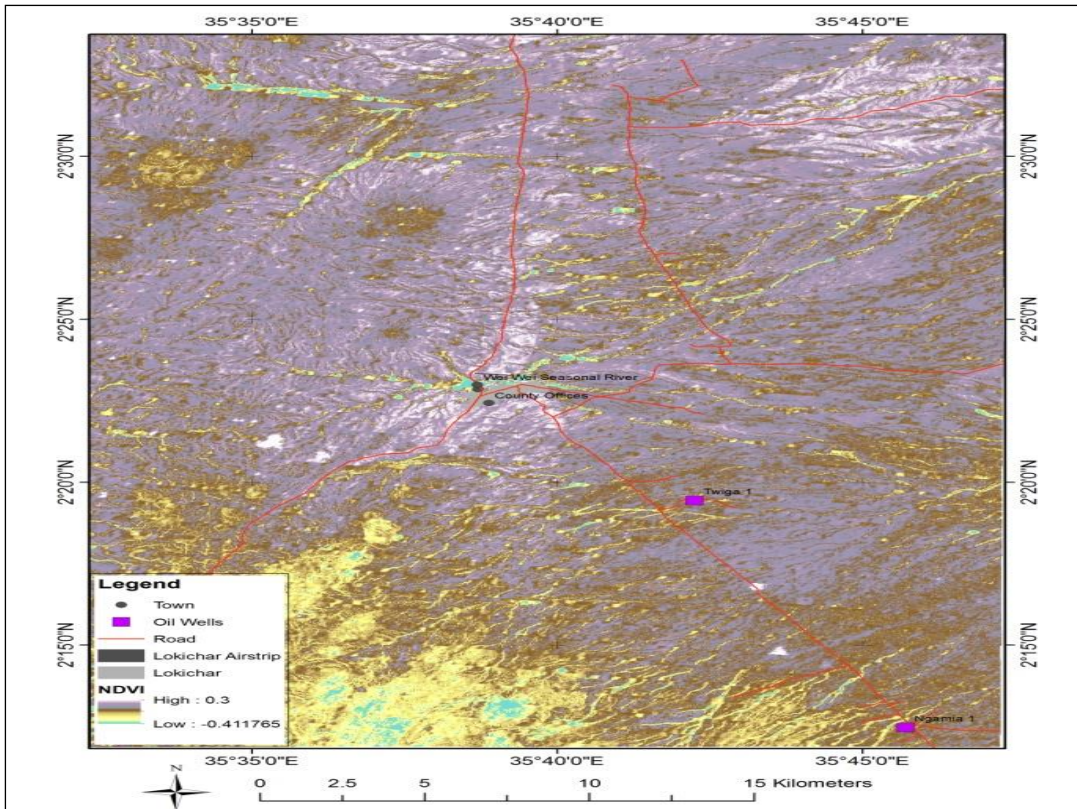
f2 rainy season NDVI 2006



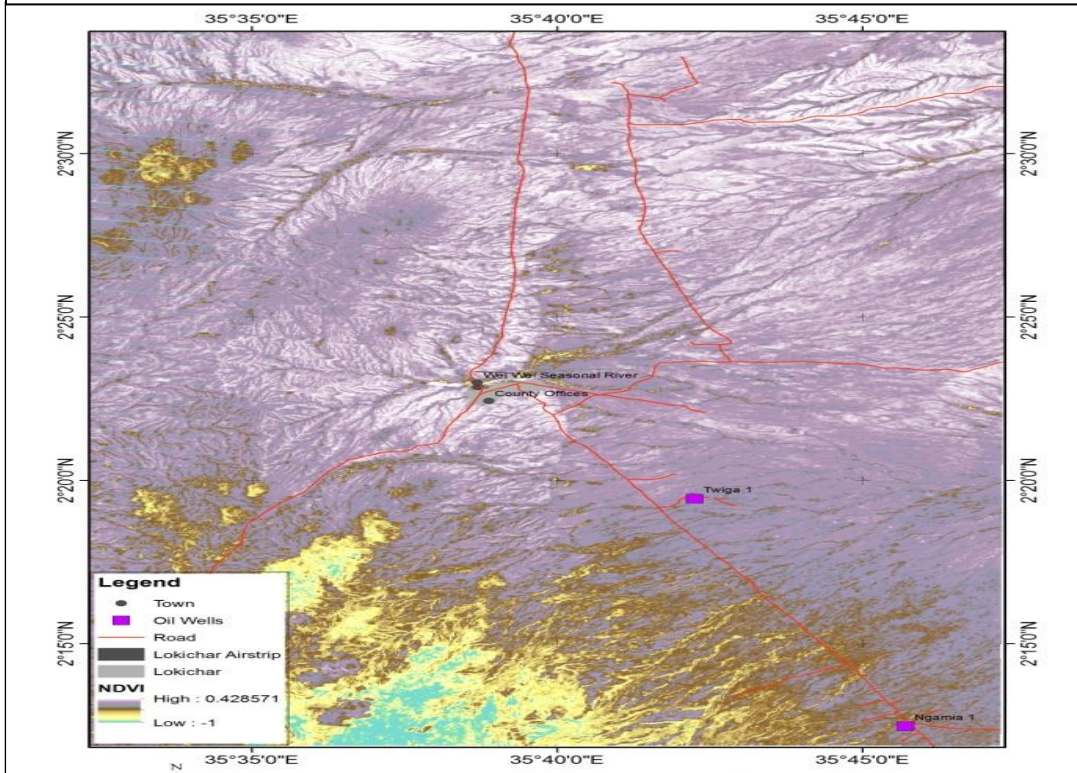
g1 dry season Oil Block 13T South Lokichar Basin NDVI 2009



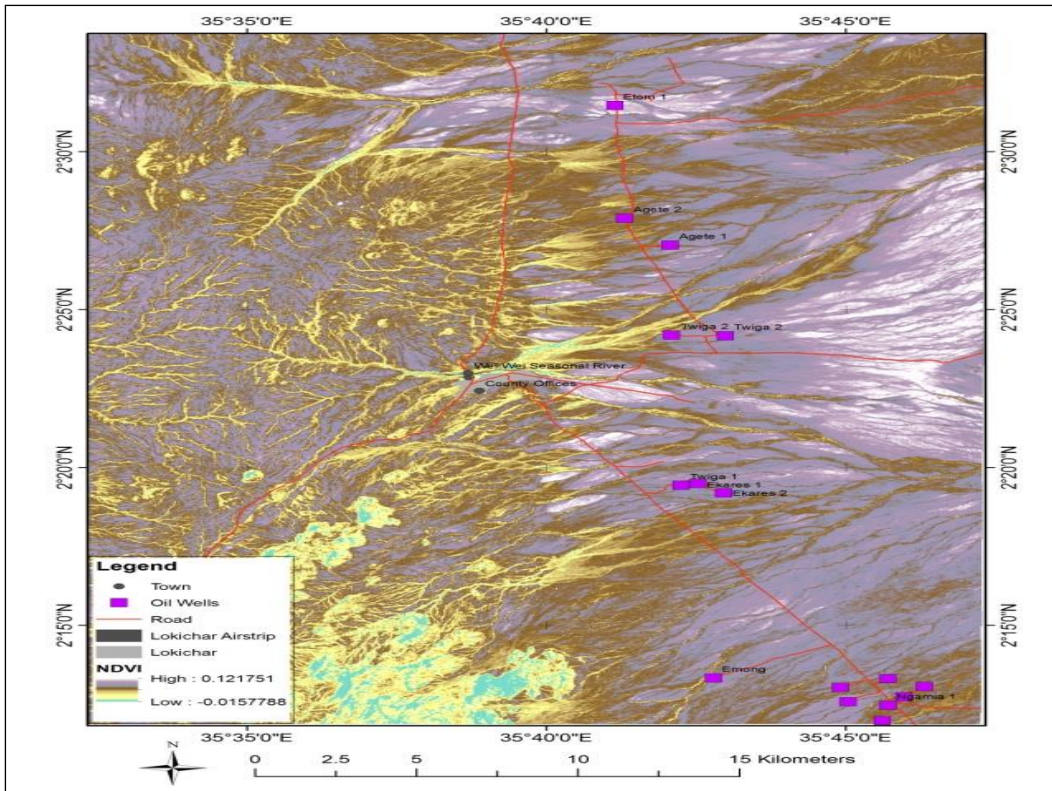
g2 rainy season NDVI 2008



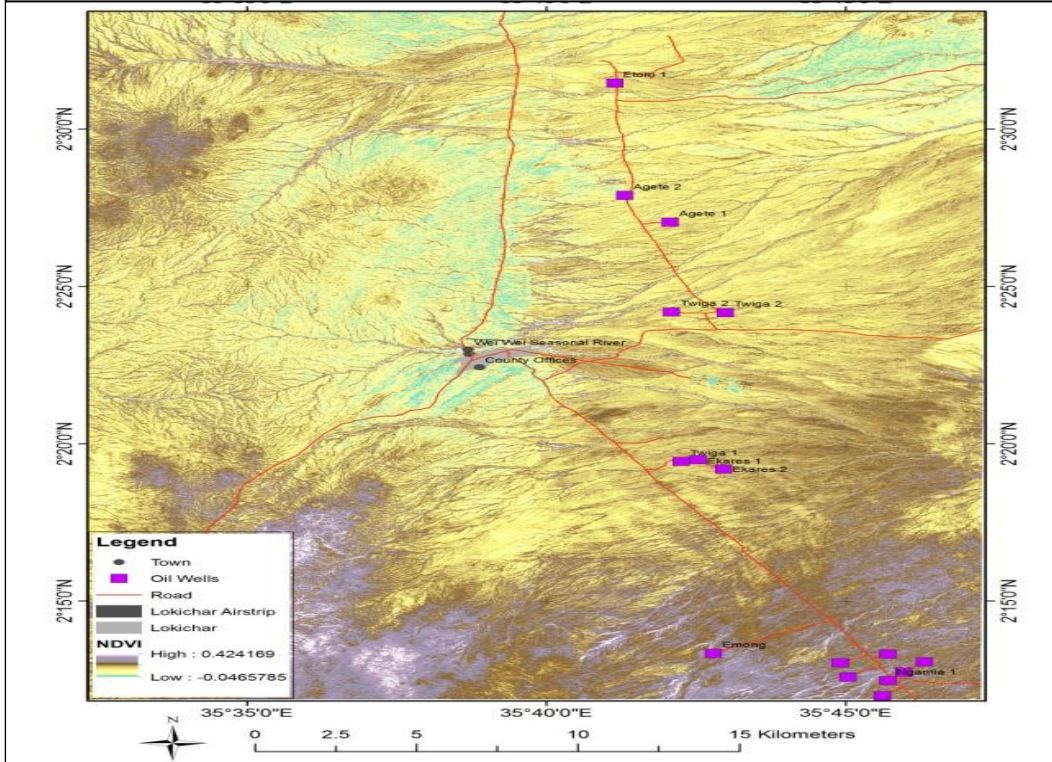
h1 dry season Oil Block 13T South Lokichar Basin NDVI 2012



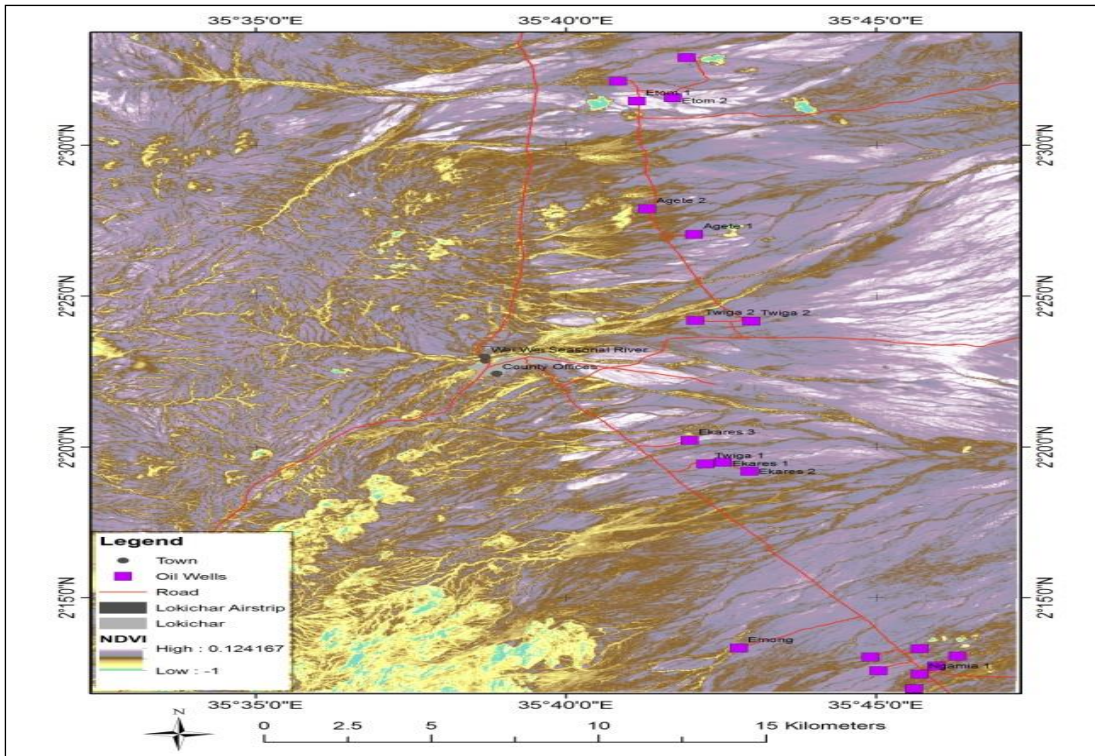
h2 rainy season Oil Block 13T South Lokichar Basin NDVI 2012



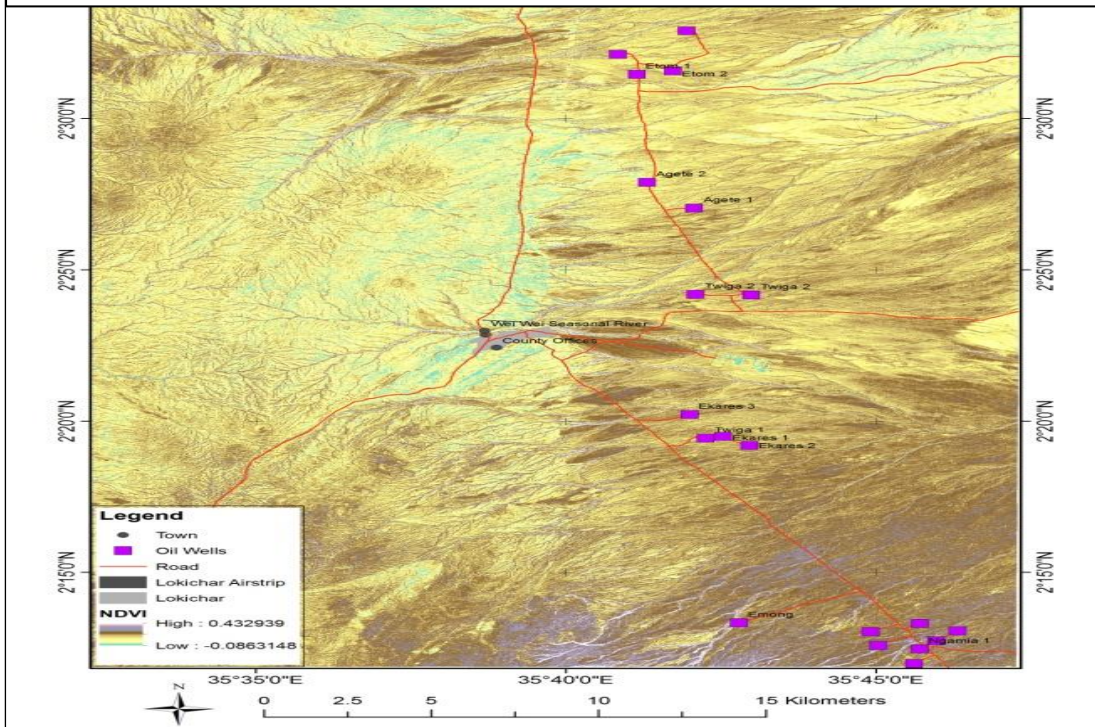
i1 dry season Oil Block 13T South Lokichar Basin NDVI 2015



i2 rainy season Oil Block 13T South Lokichar Basin NDVI 2015



j1 dry season Oil Block 13T South Lokichar Basin NDVI 2017



j2 rainy season Oil Block 13T South Lokichar Basin NDVI 2017

Plate4.3(f1;f2g1;g2,h1;h2,i1;i2,j1;j2,k1;k2,l1;l2,m1;m2):NDVI for dry and rainy seasons of South Lokichar Basin for 2006(f1;f2),2009(g1),2008(g2),2012(h1;h2),2015(i1;i2),2017(j1;j2) (Source:Landsat 5 and 8 imageries,2017)

From Plate 4.3 *f1 and f2* above, the study established that the area's high and low NDVI values were 1 and -0.12 respectively for the rainy seasons experienced between October-December. The dry season recorded NDVI values were 0.4107 and -0.138 and were determined between May-July as shown in figure 4.2 below.

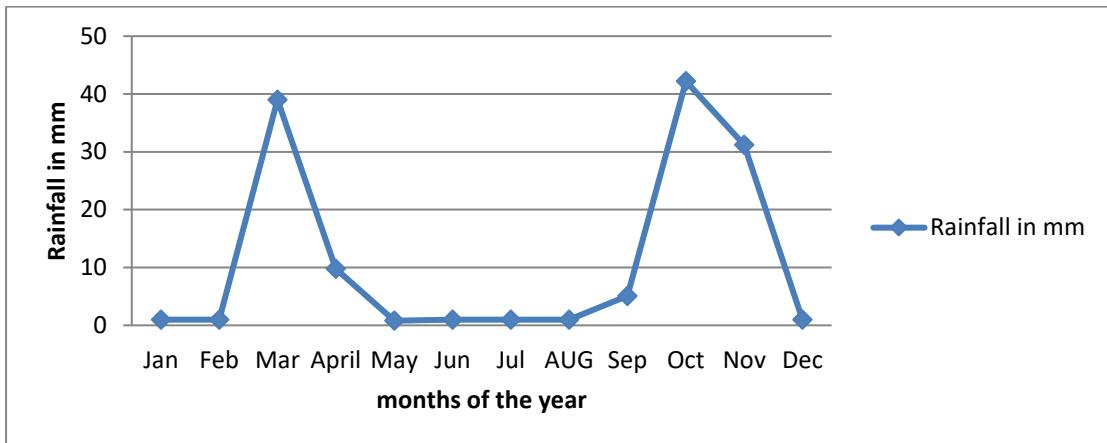
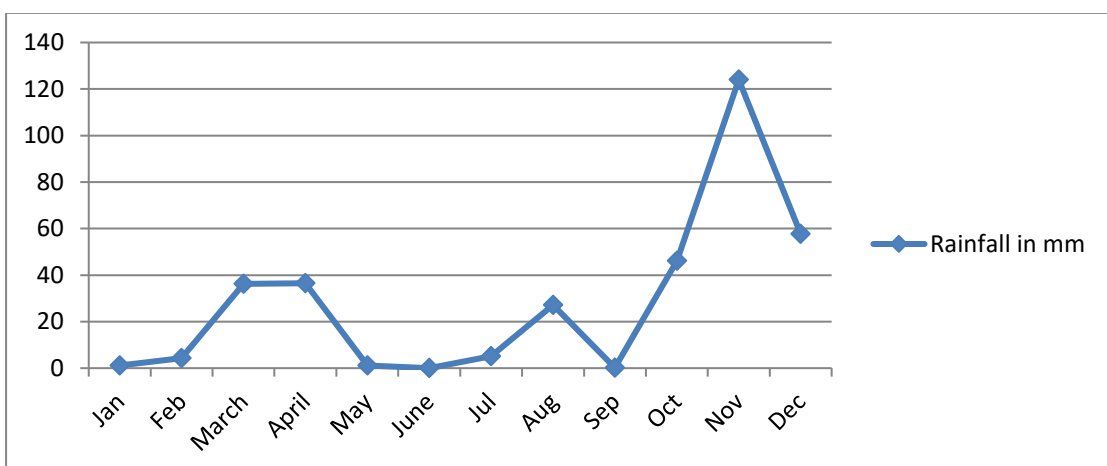


Figure 4.2: Rainfall received during the rainy and dry seasons for the year 2006 (Source: RoK, 2017)

Plate 4.3 (*g2*) had a high and low NDVI values of 1 and -0.147 respectively. These recordings were done during the rainy season experienced between September and November 2008 as shown in the rainfall data graph in figure 4.3 below.

Figure 4.3: Rainfall received in September-November rainy season for the year 2008 (Source: RoK, 2017)



Though the year did not receive as much rainfall during the rainy season as compared to the years 2012, 2015 and 2017, the fact that there was no disturbance on the vegetation cover from exploration activities may have contributed to the high NDVI recorded. The NDVI of the study area for the dry season shown in g1 was less than the one in g2 for the rainy season since rainfall is a significant factor that affects the NDVI. The highest and the lowest NDVI values for the dry season between July and September shown in figure 4.4 below were 0.4007 and -0.1038 respectively.

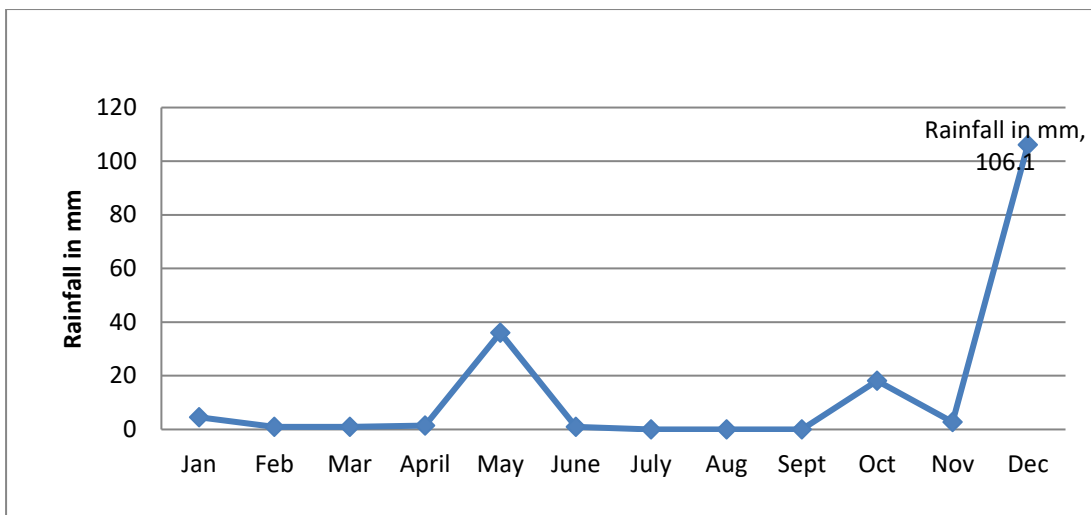


Figure 4.4: Rainfall received in June-September dry season for the year 2009 (Data Source: RoK 2017)

The NDVI of the study area in 2012 determined during the rainy season shown in figure 4.5 did indicate a slight variation when compared to the 2008 values for a similar season.

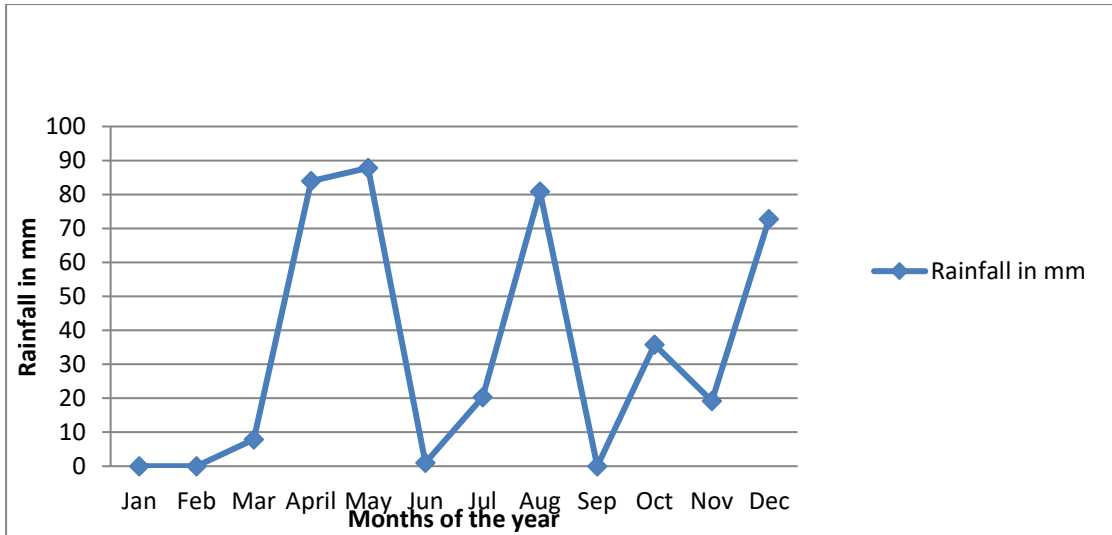


Figure 4.5: Rainfall received in March-May rainy season for the year 2012. (Source: RoK, 2017)

The highest NDVI during the rainy season experienced between March and May was 0.4285, and the lowest was -1 as shown in plate 4.3(h2). The NDVI of the study area for the dry season experienced between September and November 2013 as shown in figures 4.6 below was slightly lower than that of the dry season in the year 2009. The highest value recorded was 0.3, and the lowest was -0.4117 as shown in plate 4.3(h1). The finding implies that in 2008 before the excavation and exploration activities began the area had some more vegetation cover as compared to 2012 under the same environmental condition. The rainy period of 2008 experienced more rainfall as shown in figure 4.3 than the amount of rainfall experienced in a similar season in 2012 shown in figure 4.5. Both dry seasons in 2009 and 2013 received less than 1 millimetres of rainfall indicating that the reduction in NDVI was as a result of an external factor rather than climatic conditions in the study area.

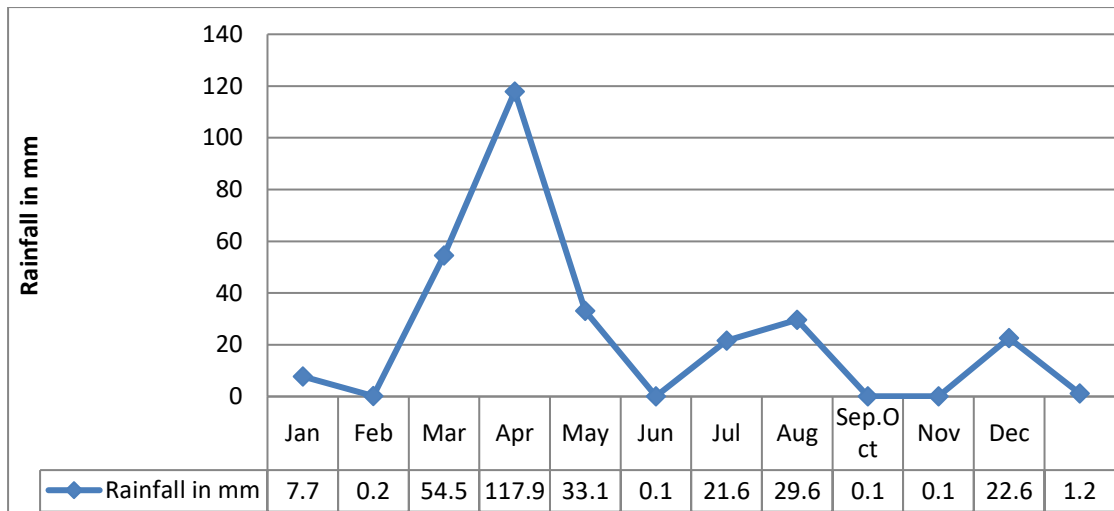


Figure 4.6: Rainfall received in September-November dry season for the year 2013 (Source: RoK, 2017)

The highest NDVI value of the study area for the rainy season experienced between March and May shown in figure 4.7 for the year 2015 was 0.4241, and the lowest was -0.0455 as indicated in plate 4.3(i2).

The value was lower than the one for year 2012 for a similar season despite the fact that the amount of rainfall received in the two seasons was almost the same as shown in figure 4.5 and 4.7. The highest NDVI for the dry season determined between July and September of the year 2015 as shown in figure 4.7 below was 0.124167, and the lowest was -1 shown in plate 4.3(i1) which was slightly lower than the one recorded in the year 2012 in a similar season.

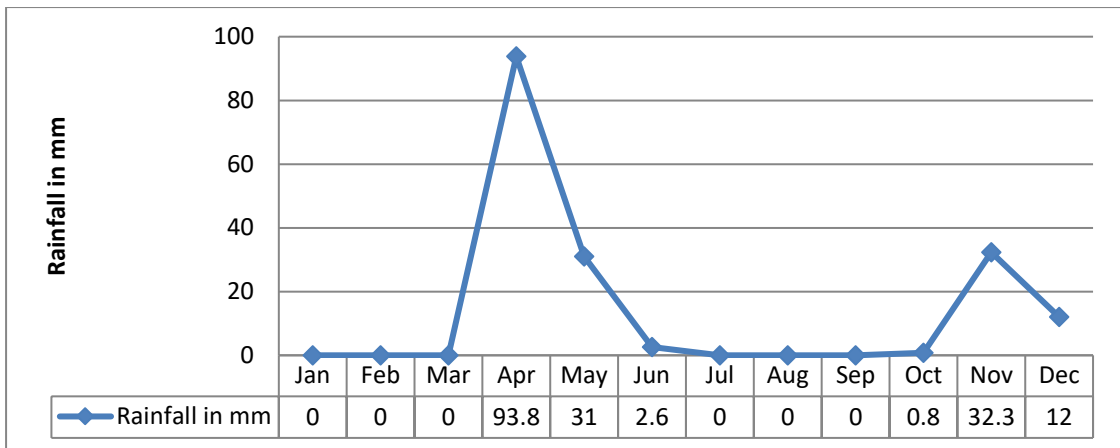


Figure 4.7: Rainfall received in both March-May rainy season and July-September dry seasons for the year 2015 (Source:RoK, 2017)

The study area recorded the lowest NDVI value in the year 2017. The highest NDVI value determined during the rainy season between August and October shown in figure 4.8 was 0.410939 and the lowest value was -0.0863 indicated in plate 4.3 (i1). The highest and lowest NDVI values for the dry season experienced between May and July shown in figure 4.8 was 0.12157 and 0.0157 as indicated in plate 4.3(i1). These values were lower compared to the NDVI determined under similar environmental conditions in 2015.

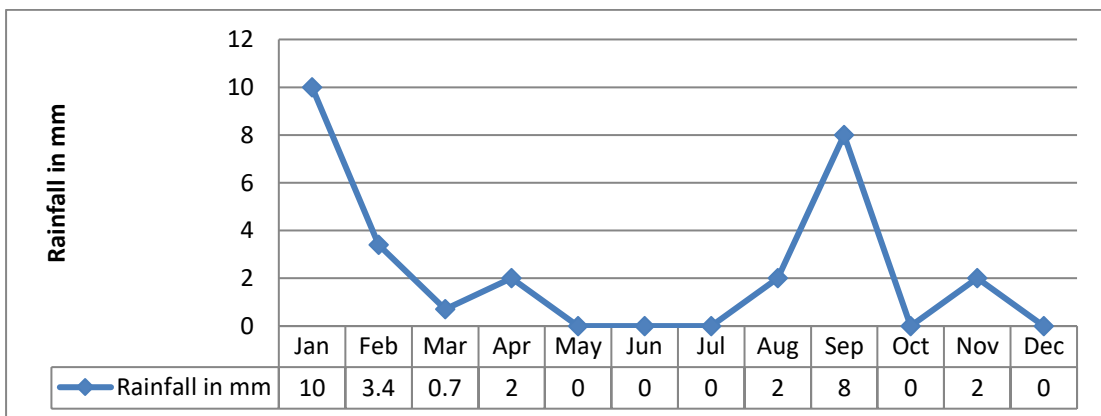


Figure 4.8: Rainfall received in both August-October rainy season and May-July dry seasons for the year 2017 (Source:RoK 2017)

The NDVI of the study area between 2006 and 2009 was constant in both dry and rainy seasons but started to decline from the year 2012 through 2017. The study

attributes the decline to the construction of the oil Well pads and access roads in Oil Block 13T South Lokichar Basin. This is due to the fact that the construction of Well pads and the access roads in the study area affected the vegetation abundance in the study area hence declining NDVI. Several factors such as temperatures, animal defoliations; rainfall and clearance of the land cover vegetation through excavation (Gaur, 2016, Zhao, 2017), may affect the NDVI of an area,

As noted in figures 4.15 and figure 4.16 there was a very slight variation in temperatures in the study area, and therefore this factor seemed to be constant, and this is evidenced by the average NDVI for the region during the dry seasons. The local communities depend on pastoral farming as discussed in section 4.4.5. The chances of their livestock having increased to defoliate the vegetation were minimal, since as noted in section 4.4.15, their livestock were declining due to increased trans-boundary conflicts resulting to raiding of their livestock. In addition an interview with an executive director of Friends of Lake Turkana a local NGO revealed that the locals do lose a lot of livestock during the dry seasons hence the probability of the livestock increasing was minimal. The fact that the NDVI declined in both dry and rainy seasons means that rainfall was not the only factor contributing to the reduction. The variation in the amount of rainfall experienced during the rainy seasons was minimal indicating that rainfall had a little significance on the NDVI value variations over the different years rainy seasons. This means that declining vegetation cover and increasing bareland was the primary factor causing the decline in NDVI value. The bareland as noted in table 4.2 increased by 117% from 2012 to 2017 from an area size of 8245 ha to 17922 ha. The study attributes the increased bareland to the constructed Well pads and access roads. This led to a significant change of NDVI in the study area as shown in section 4.3.1.1.1 below.

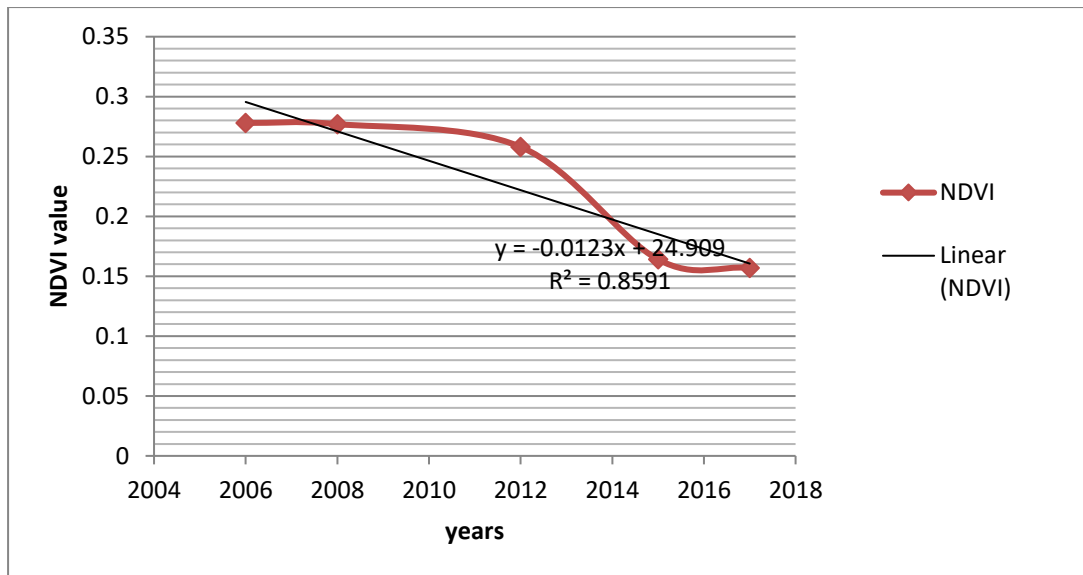


Figure 4.9: Trend of average NDVI value of the study area for the rainy seasons (Source: Landsat images 2006; 2008, 2013; 2015 & 2017)

4.3.1.1.1 Pearson Linear Correlation Analysis for the Trend of NDVI for the Rainy Season from 2006 to 2017 in the Study Area

The analysis in figure 4.9 above indicated a very strong negative linear correlation with a Pearson correlation R-value of -0.86. This means that the NDVI was decreasing with time from 2006 to 2017. The NDVI declined due to the Land cover/land use change. As noted in figure 4.9, the decline between 2006 and 2012 was quite minimal as compared to the decline of the NDVI between 2012 and 2017. This could be explained by the fact that, very little oil and gas exploration activities had taken place between 2006 and 2012 with only two wells drilled. This is contrary to the period between 2012 and 2017, a period where most of the wells were drilled in addition to the Kapese Integrated Support Base. The fact that all these NDVI values were determined during the rainy seasons across the years and as noted earlier, the local communities are pastoralists hence the level of defoliation may not have significantly changed, affirms this study assertion that, another factor could have contributed to the declining NDVI

values and this could only be as a result of the oil and gas exploration activities which comes with a lot of vegetation clearing.

Figure 4.10 below shows the trend of the NDVI of the study area across the years determined during the dry season. It shows a strong negative linear correlation with an R- correlation factor of -0.97. The fact that the NDVI too was decreasing across the years is an indication that the Well pads and access roads being built were clearing the vegetation cover in the community grazing areas. The fact that the area under riverine forest vegetation and mainland patches of dry forest vegetation were declining during the dry seasons as shown in the land use cover maps in section 4.3.1.3, would have resulted from defoliation by livestock after displacement from their indigenous community grazing lands like ISB land at Kapese

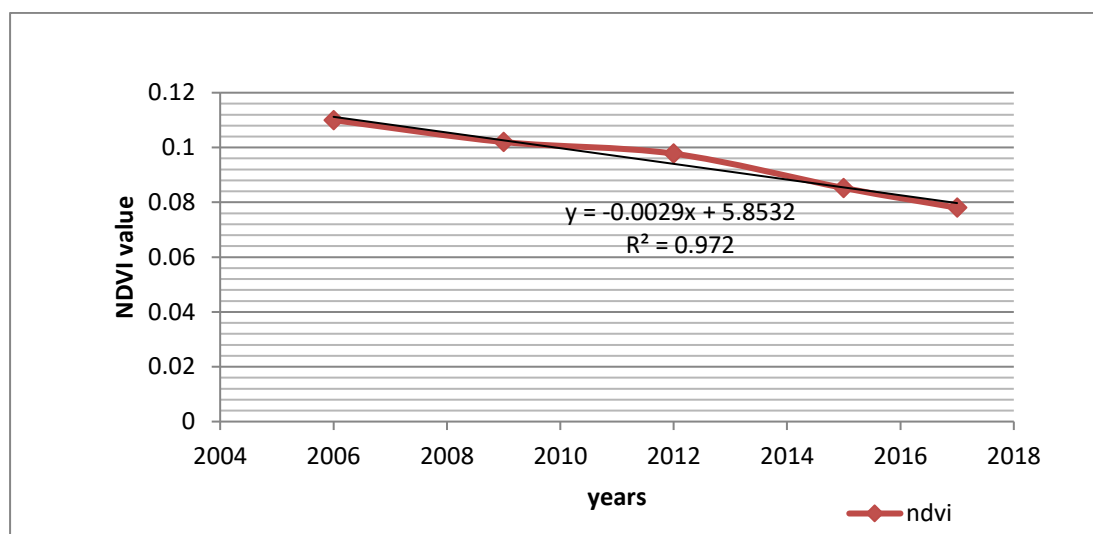


Figure 4.10: Trend of average NDVI value of the study area for the dry seasons (Source: Landsat imageries 2006; 2009, 2013; 2015, 2017)

The fact that the NDVI values for the study area during the dry seasons were less than those recorded during the rainy seasons is a clear indication that rainfall influences the NDVI value. The NDVI values determined for the rainy seasons without any other external influence in the study area should have been the same since the area has homogenous vegetation. However as noted, this was not the case as the NDVI values

for the rainy season declined from 1 for high value and -0.147059 for lower value in 2006 to 0.121751 for high value and -0.0157788 for lower value in 2017. The findings of this study imply that, since rainfall was abundant across the years during the rainy seasons, then vegetation clearance resulting from oil and gas exploration activities contributed immensely to the declining of the NDVI value across the years.

4.3.1.1.2 Paired T-Test and Linear Regression Analysis in Testing Hypothesis on the NDVI Value in the Study Area Pre and Post Commencement of Oil and Gas Exploration

The statistical significance (2-tailed p -value) of the paired t-test was 0.0091. As the p -value was less than 0.05 (i.e., $p < .05$), the study concludes that there was a statistically significant difference on the NDVI value before and after the oil and gas exploration activities began in Oil Block 13T South Lokichar Basin hence the H_0 was rejected and the study failed to reject the H_1 .

The difference is due to the decreased vegetation cover and increased bareland due to construction of Well pads and access roads as evidenced by linear regression analysis below. A linear regression analysis of bareland area size and NDVI across the years did show a strong linear regression with R value of 0.953. The statistical significance (2-tailed p -value) of the two sample t-test was 0.012 at 95 % confidence interval. As the p value was < than 0.05 as shown in table 4 below, the study concludes that increased bareland due to vegetation clearance led to a decline in NDVI value in the study area.

Table 4.1: Linear regression analysis of NDVI versus area size in hectares of the bareland for the study area

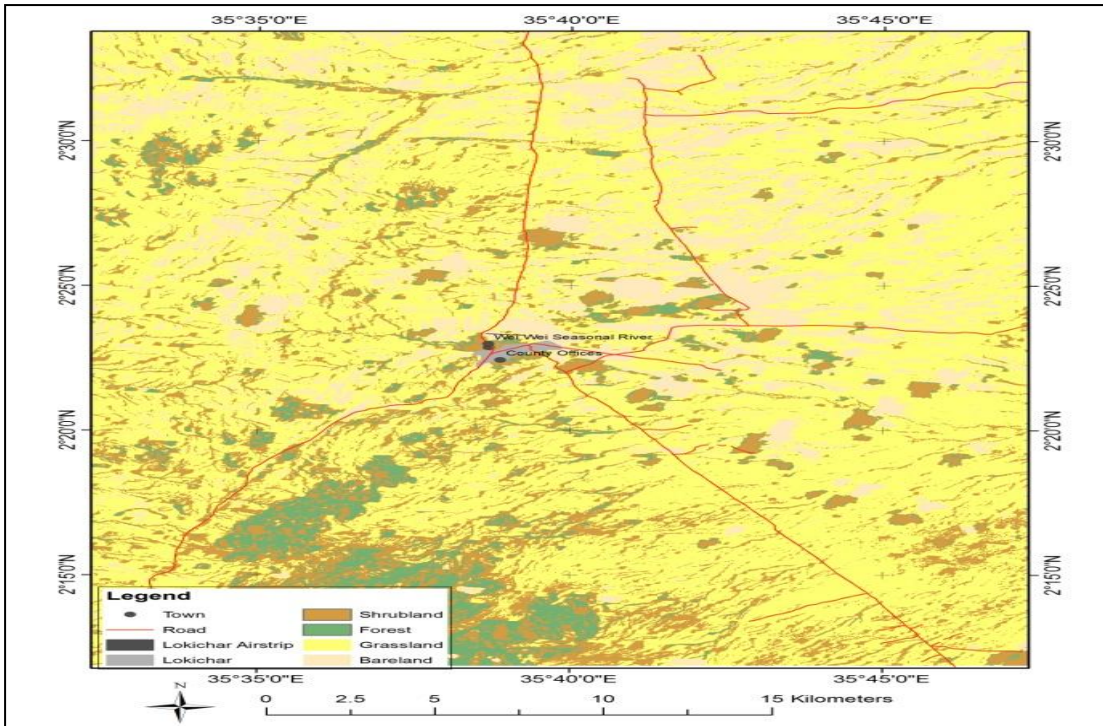
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	
1	.953 ^a	.909	.879	.02141	

ANOVA ^a					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	.014	1	.014	29.934	.012 ^b
Residual	.001	3	.000		
Total	.015	4			

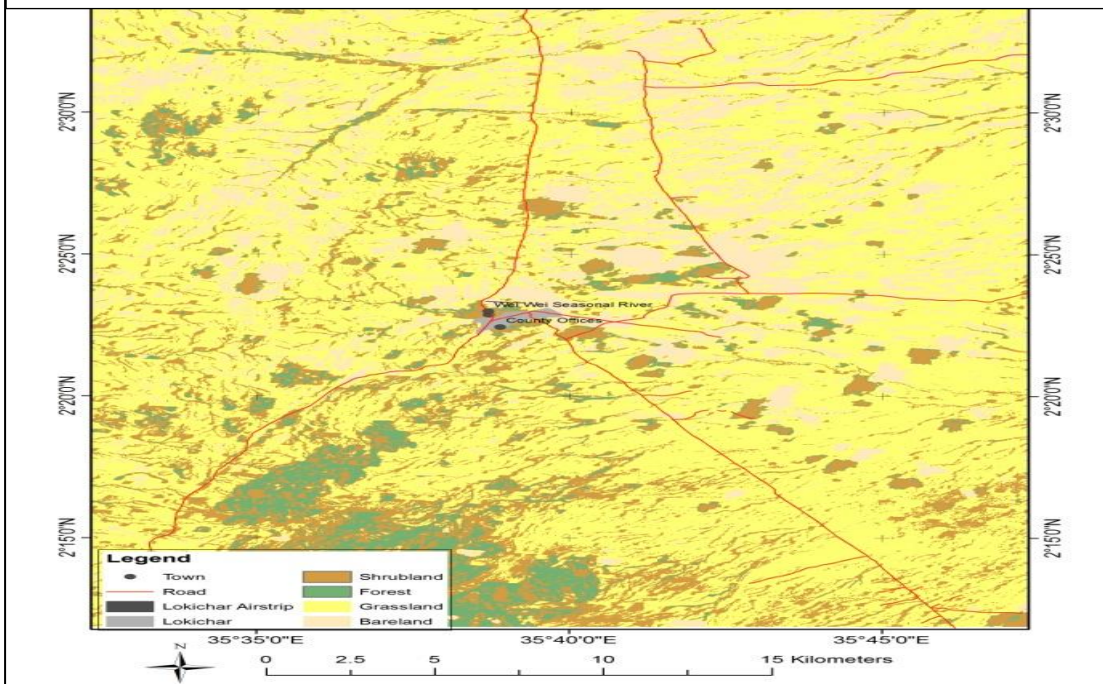
Coefficients					
Model	Unstandardised Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	.388	.031		12.512	.001
land area	-1.286E-005	.000	-.953	-5.471	.012

4.3.1.2 Land Use/Land cover changes Maps of the Study Area

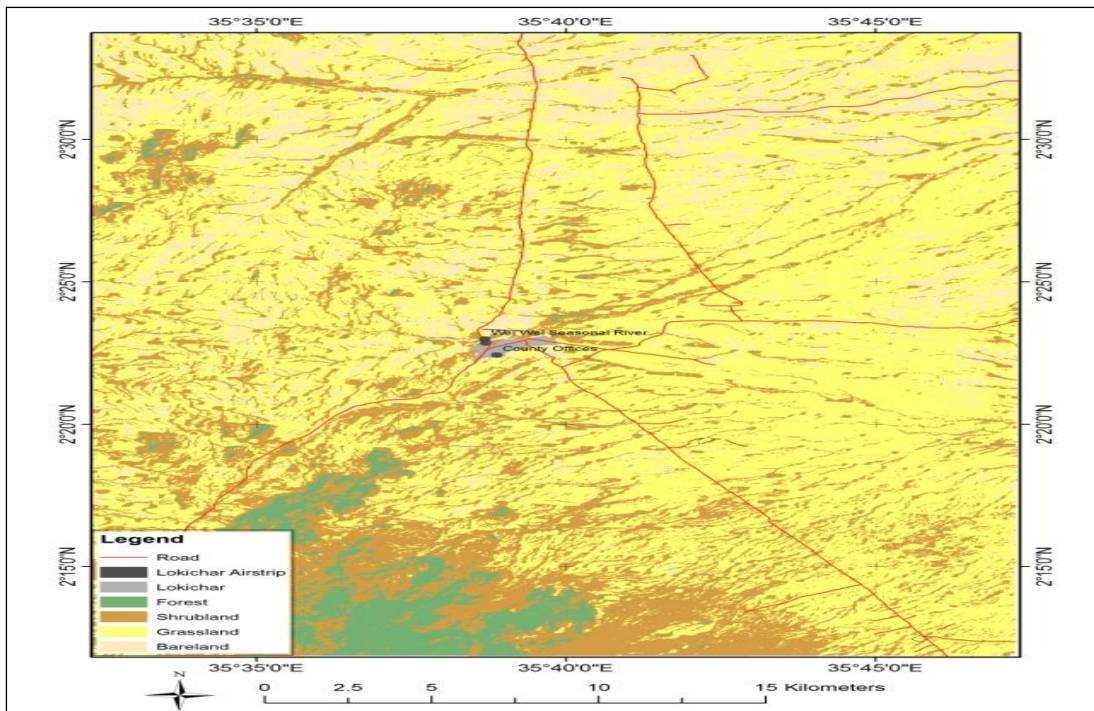
Plate 4.4(k₁;k₂,l₁;l₂,m₁;m₂,n₁;n₂, and o₁;o₂) below shows the land use land cover maps of the study area for 2006,2008/2009 2012,2015 and 2017 for both dry and rainy season. Plate 4.4(k₁ and k₂,l₁ and l₂) shows the classified maps for both dry and rainy seasons of the study area for the year 2006 and 2009/2008.The area is covered with shrubs, riverine forest and grassland which are the predominant vegetation cover in Turkana County as noted in section 3.2.3 and section 4.3.1.



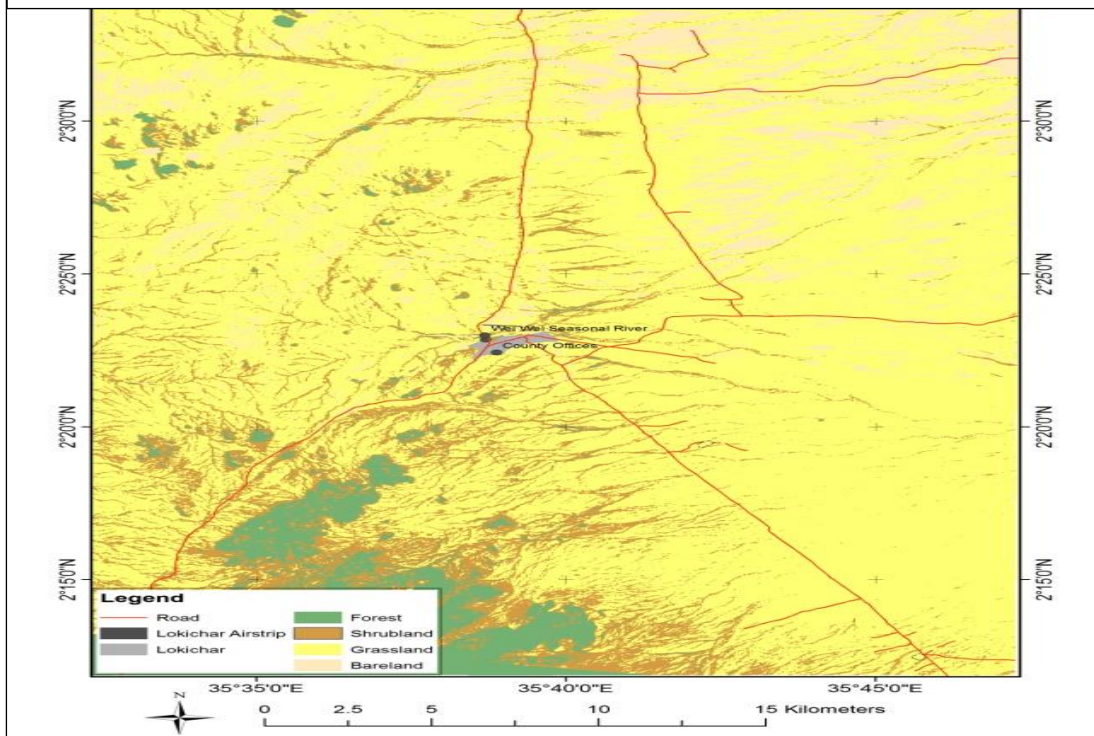
k1 Land use map dry season 2006



k1 Land use map rainy season 2006



11 Land use map dry season 2009



12 Land use map rainy season 2008

The oil and gas exploration activities had not begun, and therefore the changes on the land cover were as a result of climatic factors. Table 4.2 below shows the land cover use of the total 123794.840 hectares of the study area. The bareland increased by 41% from

10625.220 hectares during the rainy season to 19886.13 hectares for the dry season in year 2006 within the area of study .The other vegetation cover indicated a decline during the dry seasons in both 2006 and 2008/2009. The bareland decreased by 15 % between 2006 to 2008 for the rainy season and increased by 12% for the dry seasons. More than 60% of the vegetation cover in the study area consists of grassland, followed by shrubland at 25% in both rainy and dry seasons.

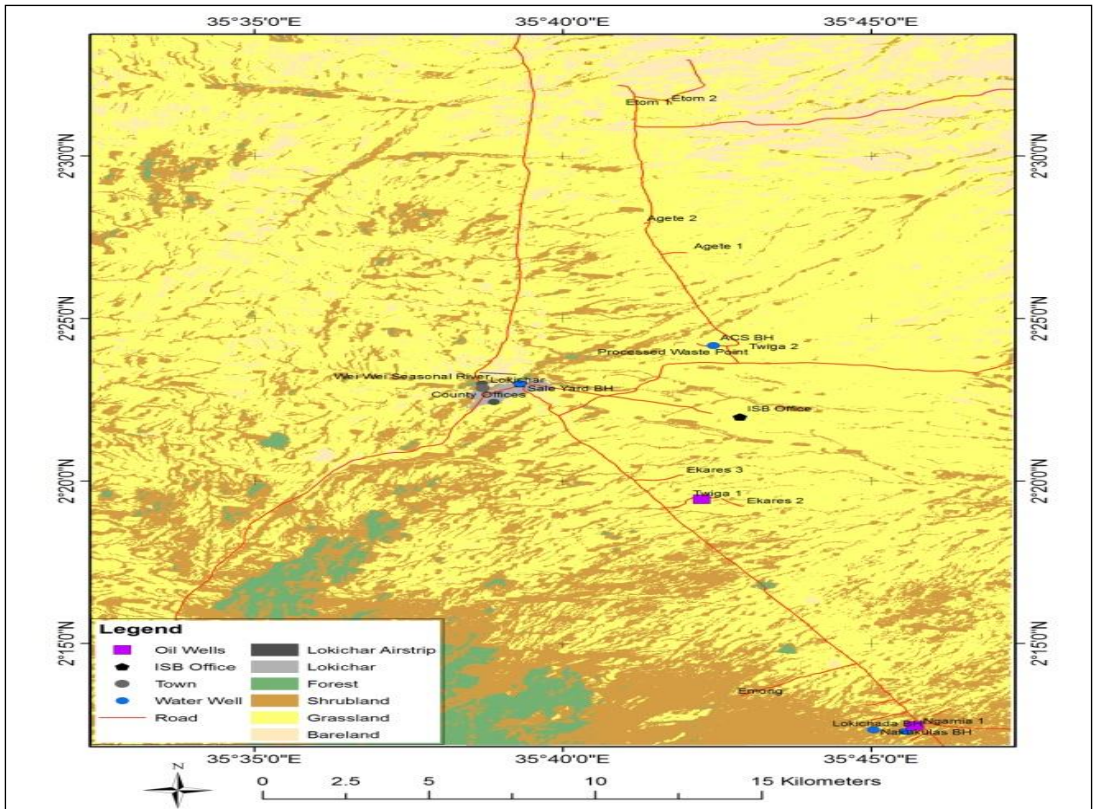
Table 4.2:Land use/Land cover changes in hectares before the oil and gas exploration begun

Year 2006

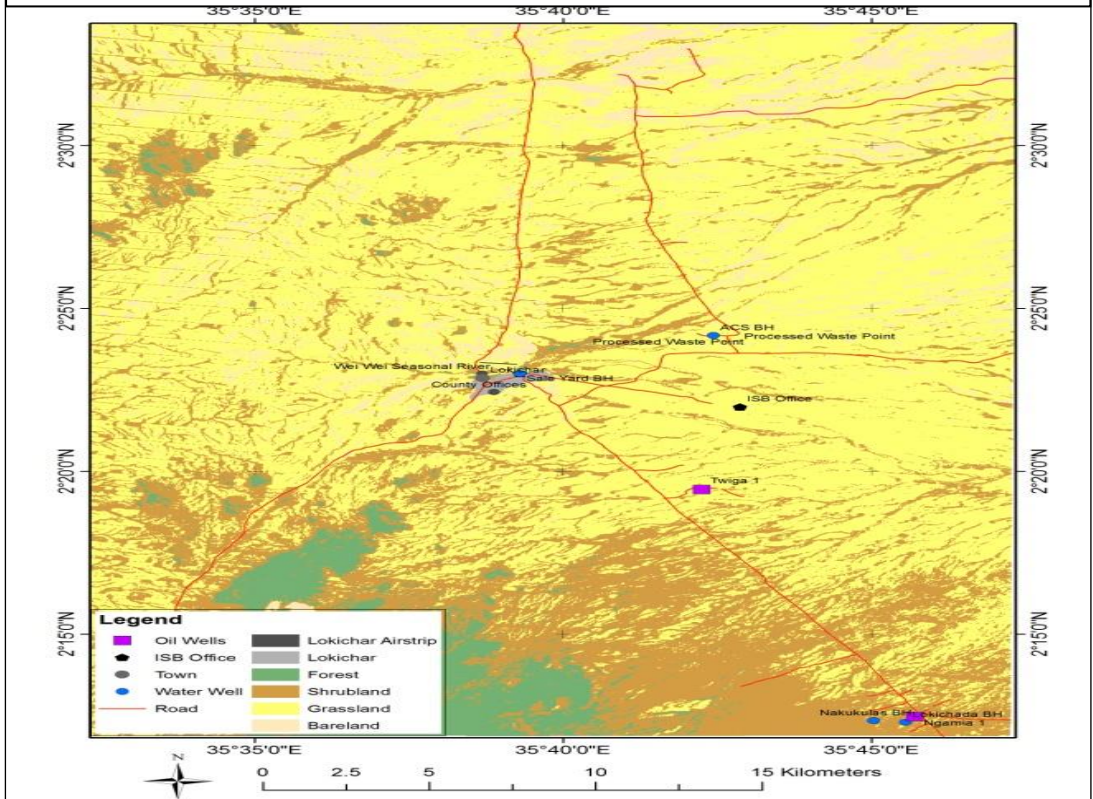
Land use	Area : rainy season	Area: Dry season
Forest	7656.98	5255.73
Shrubland	33578.92	32828.31
Grassland	71933.61	65824.56
Bareland	10625.220	19886.13
Total	123794.840	123794.84

Year 2008

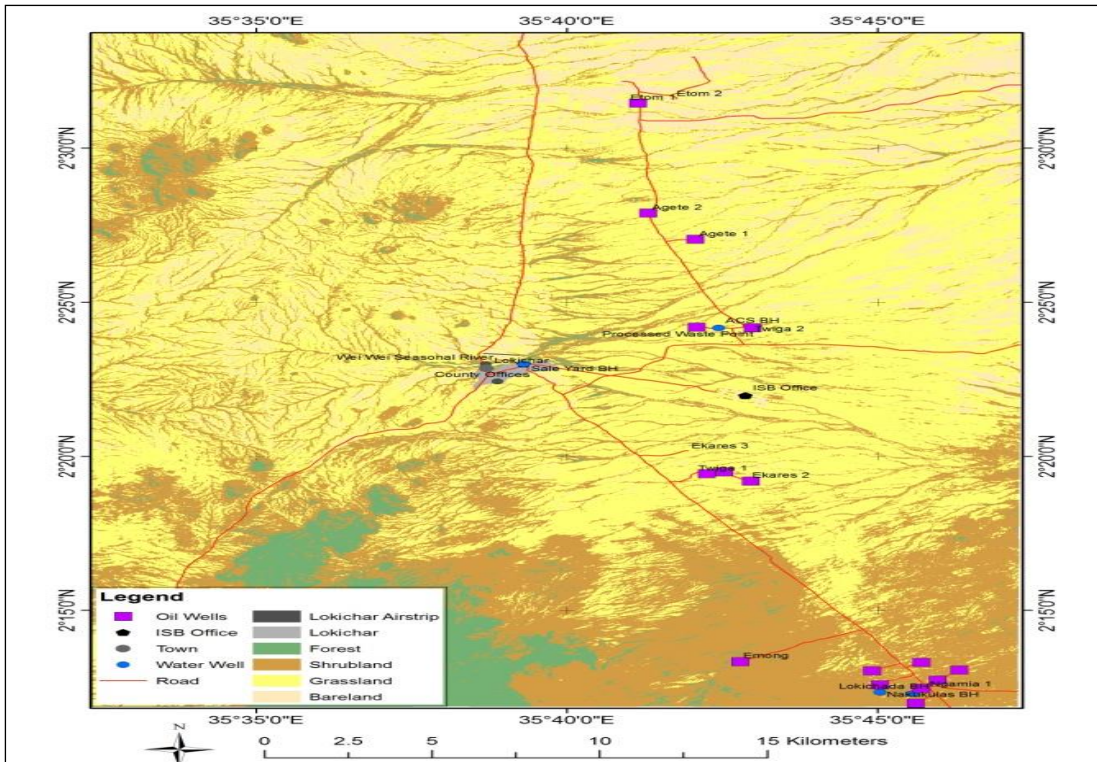
Land use	Area: rainy season	Area : Dry season
Forest	5648.490	4597.830
Shrubland	29106.360	28600.120
Grassland	80007.400	73212.800
Bareland	9032.500	17384.000
Total	123794.840	123794.840



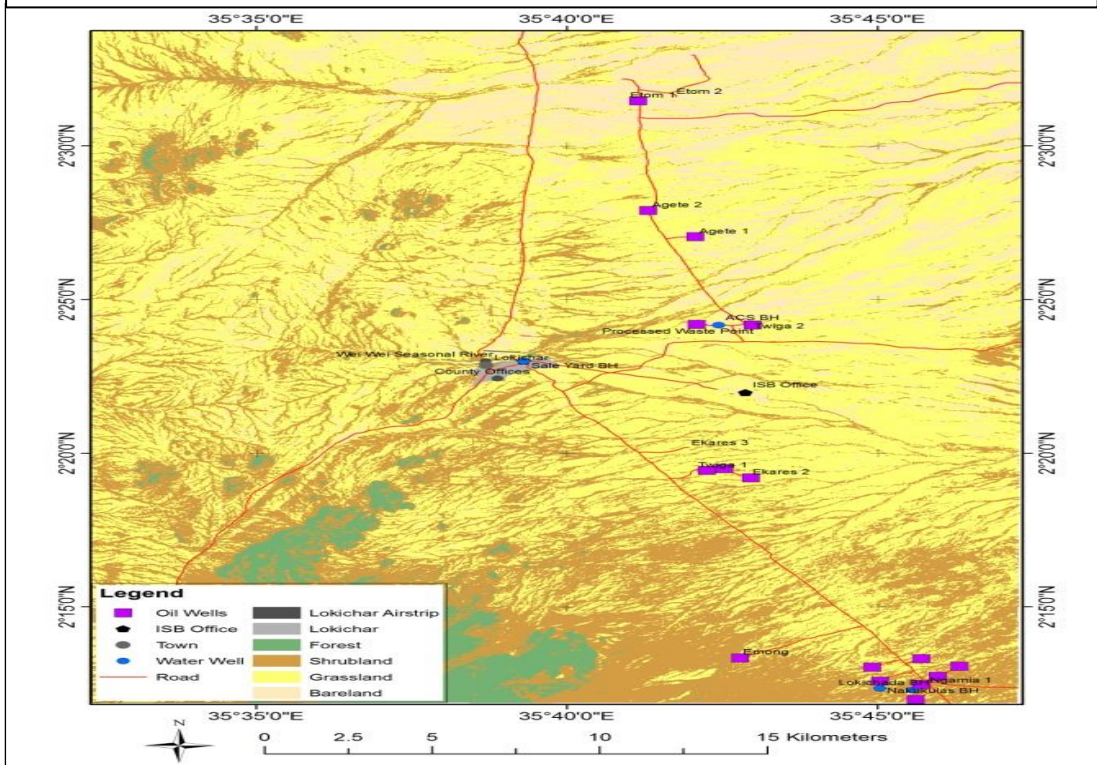
m1 Land use map dry season 2012



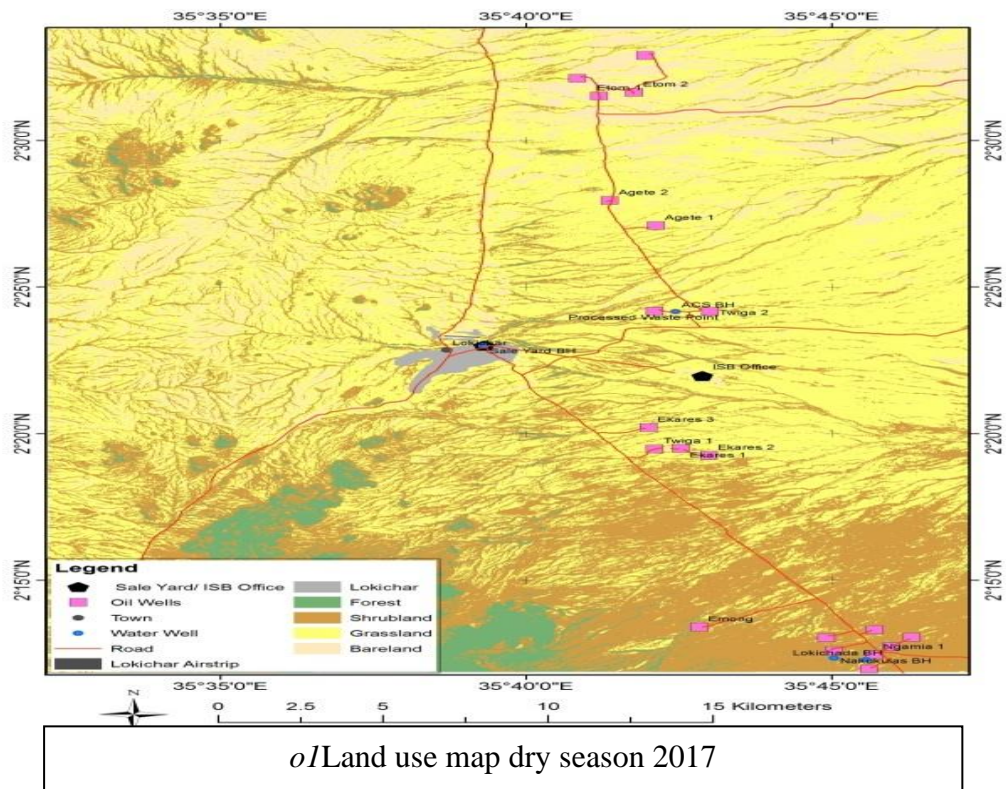
m2 Land use map rainy season 2012



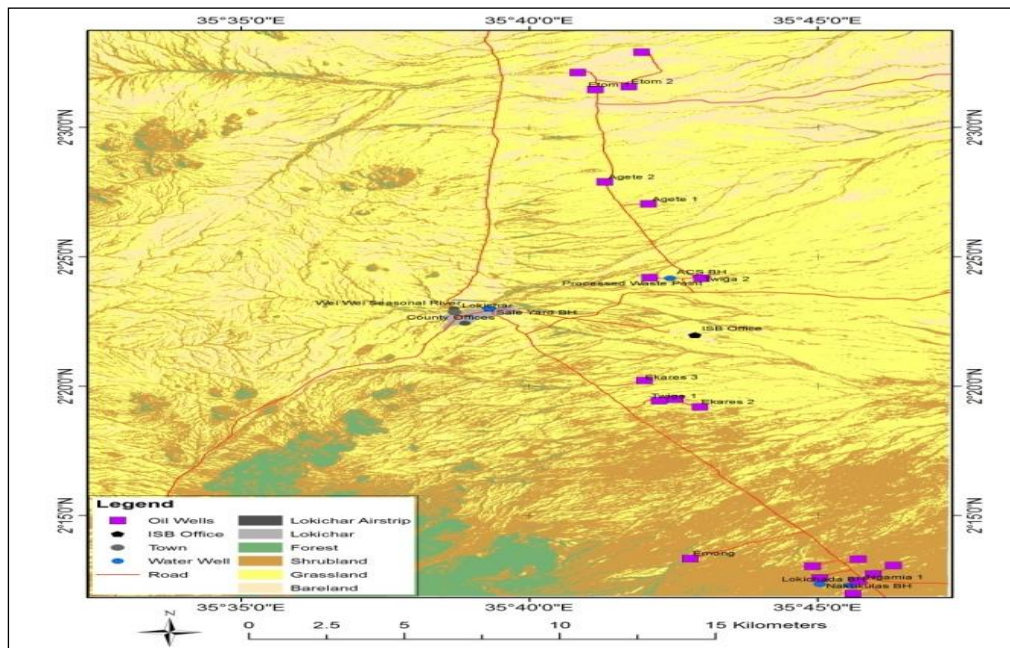
n1 Land use map dry season 2015



n2 Land use map rainy season 2015



o1 Land use map dry season 2017



o2 Land use map rainy season 2017

Plate 4.4(*k1*; *k2*, *l1*; *l2*, *m1*; *m2*, *n1*; *n2*, and *o1*; *o2*): Land cover/land use maps for dry and rainy seasons of Oil Block 13T South Lokichar Basin (Source: Landsat 5 and 8 acquired and classified images)

Plate 4.4 (*m1* and *m2*, *n1* and *n2* and *o1* and *o2*) shows the study area after the commencement of oil and gas exploration. Well pads and access roads which have been

increasing in number with each subsequent year from 2012 to 2017 are visible. There is a possibility that the construction of Well pads and access roads led to the decline of the dominant grass cover vegetation and shrubland since the bareland was increasing with each subsequent year since 2012 as shown in table 4.3 below. The Southern part of the study area had a dense riverine vegetation since the seasonal river WeiWei shown in the study map passes through the area. Table 4.3 below shows the land cover/land use changes of the study area from year 2012 to 2017.

Table 4.3: Land use/land cover changes in hectares after oil and gas exploration begun

Year 2012		
Land use	Area Rainy season	Area Dry season
Forest	5922.090	4908.42
Shrubland	36450.750	28639.39
Grassland	76798.000	75094.8
Bareland	8224.000	12452.2
Well pads	21.680	21.6866
Total	123794.840	123794.84
Year 2015		
Land use	Area rainy season	Area Dry season
Forest	5876.310	5531.67
Shrubland	33800.100	33334.2
Grassland	67271.800	66820.4
Bareland	16667.600	17929
Well pads	273.0	273.0
Total	123794.840	123794.84
Year 2017		
Land use	Area rainy season	Area Dry season
Forest	5691.560	3641.4
Shrubland	35357.440	34045.1
Grassland	64926.680	64200.1
Bareland	17640.100	21729.20
Well pads	282.0	282.0
Total	123794.840	123794.80

From table 4.3 above, the vegetation cover during the rainy seasons declined from 5922.09 hectares for the forest, 36450.75 ha for the shrubland and 76798 ha for the grassland in 2012 to 5691.568 ha for the forest, 35357.445 ha for the shrubland and 64926.685 ha for the grassland in 2017 respectively determined during the rainy seasons. Each land use area taken during the rainy season in each year declined during the dry season indicating the negative impact of lack precipitation on vegetation cover. The bareland in 2012 increased by 51% in 2015. The variation between the size of the bareland during the rainy and dry season was 7% increase while in 2017 the bareland increased by 23% during the dry season.

The bareland increased from 8224 ha during the rainy season and 12452 ha during the dry season in 2012 to 17640.1ha and 21729.2 ha respectively in 2017, an increase of 114% and 74% for rainy and dry seasons respectively. The fact that the percentage increase of the bareland for the rainy seasons was higher than that of dry seasons between 2012 and 2017 demonstrates other factors apart from precipitation affected the vegetation. This is also evidenced by the fact that between 2006 and 2009 before the oil and gas exploration activities begun the bareland in the study area decreased by 15% for the rainy seasons and increased by only 12% for the dry seasons. The land acquired for Well pads and Integrated Support Base construction increased from 21.680 ha in 2012 to 282 ha in 2017. The area under the constructed access roads was integrated in the area under the bareland. This is deemed to increase as oil and gas exploration intensifies in the region. Except for the 173 ha ISB land, that is in one location the, areas under Well pads are scattered within Oil Block 13T South Lokichar Basin as shown in the study area map in figure 3.1 causing fragmentation of the community grazing land.

4.3.1.2.1 Two Sample T-Test for Hypothesis on Land Cover Area Change Pre and Post Commencement of Oil and Gas Exploration in Oil Block 13T South Lokichar Basin

Appendix 7.13 shows that the area under vegetation cover had declined since the oil and gas exploration began. A mean difference between the size of the land covered by forest, grassland and shrubland before the oil and gas exploration began and after of 1589.12 ha, 6248 ha and 7274.211 ha were recorded respectively with standard deviations of 937.69, 6549.1 and 5359.42 respectively.

The analysis had standard errors of the mean of 454.45 ha, 7221.57ha and 2984.92 ha respectively and 90% confidence intervals of -2343.947-5522.19, 66590.73-54104.72, -4352.191-18900.61 respectively. The obtained *t*-values were 3.4968, 0.8645 and 2.437 at 1.199, 1.2225, 2.2363 respectively degrees of freedom, and the statistical significance (2-tailed *p*-value) of the two sample *t*-test ($\Pr(|T| > |t|)$ under $H_a: \text{mean}(\text{diff}) \neq 0$), which were; 0.0718, 0.07381 and 0.0609 respectively.

As the *p*-values were less than 0.1 (i.e., $p < 0.1$), the study concluded that, that there is a statistically significant difference between the area under vegetation cover before the oil and gas exploration activities began and after and therefore the study rejected the null hypothesis and failed to reject the alternative hypothesis that there was a significant change on vegetation cover since oil and gas exploration commenced in Oil Block 13T South Lokichar Basin. This is consistent with Osei *et al.* 2006 for a study done in Niger Delta.

4.3.1.2 Impacts of vegetation clearance to the wildlife

There were a number of animal and bird species that were noted in areas where vegetation clearing had not taken place. Animals such as cape hare, dwarf mongoose, black-backed jackal and ground squirrel were spotted during the field study. The study established that the area had a vibrant diversity of birds in areas where drilling activities had not reached. Some of the bird species identified included, Red-billed Hornbill, Black-headed lover, Black-bellied go-away bird, White-browed sparrow weaver and Chestnut-bellied sandgrouse among others. Insects such as termites evidenced by the many termites hills were also spotted in the study area. The birds, according to the locals were seen to flee whenever seismic and vibration activities were being carried out. None of the mentioned species was spotted in excavated areas around the Well pads. This is in agreement with Ogutu *etal.* (2016) .See fauna species identified in the areas not excavated around the Well pads in plates 4.5, 4.6, 4.7 and 4.8 below.

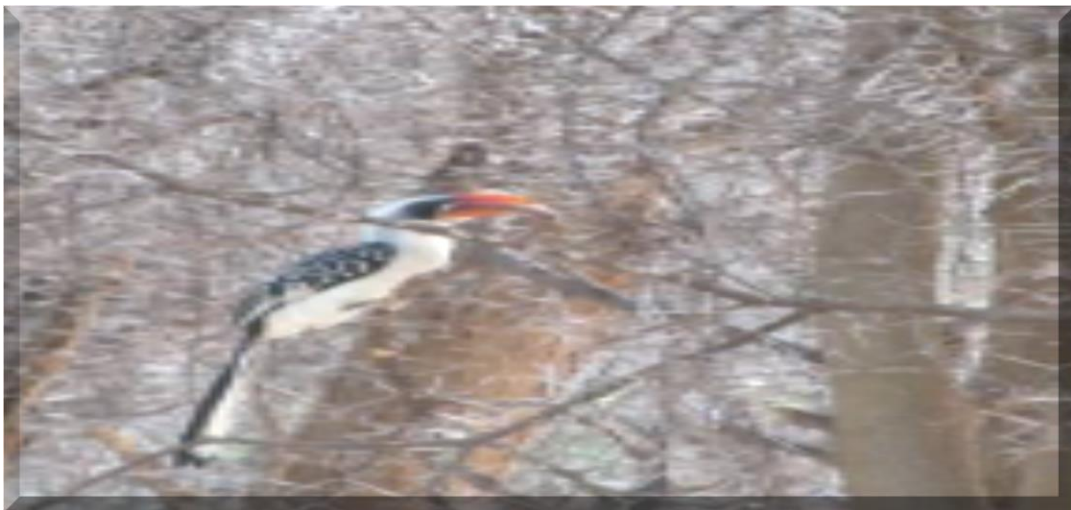


Plate 4.5: The Red-bellied go-away bird (Photo: Researcher, 2017)

Red-billed horn-billed bird on an Acacia tree where oil drilling had not begun .



4.6: The White-bellied bird (Photo: Researcher, 2017)

Plate 4.6 shows a White-bellied go-away bird spotted on the vegetation at Nakukulus. Insects such as termites, evidenced by numerous termite hills were also spotted in areas where exploration had not taken place as shown in plate 4.7 below.



Plate 4.7: A Termite Hill (Photo: Researcher, 2017)

Some other species seen in areas where drilling had not taken place in the study area were reptiles like snakes as shown in plate 4.8 below



Plate 4.8:A Snake up a tree (Photo: Researcher, 2017)

The locals pointed out that these fauna were all present in areas where research and drilling had taken place, an issue that was validated by this study with data from an EIA carried out in 2011 before oil and gas exploration activities began. Proper measure needs to be taken for this fauna to be conserved. The fact that the local communities in these areas practise pastoralism as their primary source of livelihood as noted in section.4.4.5, sustainable management of the vegetation cover is of paramount importance. There is a need to carry out restoration of the dry wells and do landscaping of the excavated areas to help in conservation of these fauna species. Most of these fauna species have adapted to survive in areas with such climatic conditions, and hence they are prone to death and extinction if restoration and landscaping are not fast-tracked.

The study identified four dry wells whose restoration had not been carried out by August 2017. The internationally accepted period for dry well restoration according to EPA is 90 days (Elkin, 2012). The dry wells were Etiir, Cheptuket, Emong and Ekoswan. An interview with the Oil Company environmental officer indicated that the company had strictly adhered to the law on environmental restoration whenever they encountered a dry well during exploration. However, this study found the claim untrue

because Emong and Ekoswan Well pads were drilled in 2014 and by August 2017 restoration had not be done as shown in plate 4.9 below. This contradicts the Kenya Environmental Impact Assessment and Audit Act of 2003 that requires land restoration once a project has been decommissioned. The oil explorers too fails to conform to the IFC performance standard that requires land restoration within 90 days for environmental sustainability. With the process of oil and gas exploration deemed to intensify in Northern Kenya and the various parts of the country, the Oil companies need to adopt a modern technology of oil and gas exploration such as horizontal drilling to reduce the oil and gas exploration activities ecological footprint on the grazing areas which is the primary source of livelihoods for the local communities.



Plate 4.9:Unrestored Ekoswan Well pad (Photo:Researcher, August 2017)

Adoption of horizontal drilling would agree with a research work done by Joshi (2003) who said that horizontal technology also called fracking would enhance sustainable management of vegetation cover in well-drilling sites as discussed below.

4.3.1.3 Horizontal Drilling and Land Restoration for Sustainable Management of Vegetation Cover in Turkana

According to Vandenberg (2015), horizontal drilling is the method used in drilling a well from the outward to a subsurface point just overhead the aimed oil reservoir commonly referred to as a kickoff point. He further notes that the process also entails deviating the wellbore around the curve from the vertical level to interconnect the reservoir with a near-horizontal inclination and the drill continues until the bottom hole needed is reached. Joshi (2003) records that horizontal wells are superior producers than the vertical wells and are more suitable when it comes to the aspects of environmental conservation. As noted in section 2.3.1 and established by this study through an interview with the Oil companies technical personnel shown in section 4.3.1, each vertical well requires a pond, a drilling pad, access roads and gathering line. Statoil (2016) notes that a single horizontal well can penetrate and produce oil from multiple parcels since it is the only way a rock layer can be followed to maximise the penetration distance. Also, a single horizontally drilled pad can be used to drill several wells, and this minimises the footprint of drilling operations. According to Vandenberg (2015), the University of Texas at Arlington drilled 22 wells on a single platform from an area spanning to 1100 acres and hence conserving on surface biodiversity and infrastructures.

This study established that this environmental management approach has also been adopted in one of the East African Countries in the biodiversity-rich region of Albertine Graben in Uganda whose sedimentary rock geologic formations forms part of the East Africa Rift Valley Tertiary Basin in Uganda whose Oil Block 13T South Lokichar Basin is part of in Kenyan side (Ongode, 2014). He notes that this technology was used in drilling Jobi-6 appraisal well in the environmentally sensitive Albertine Graben in

Uganda. According to Lokeris *etal.*(2014),the reason behind the adoption of this technology was in the spirit of conserving the wildlife in this ecosystem zone. Both Total Exploration and Production Uganda Group Limited and Tullow Limited Uganda adopted the technology. Helms (2008) notes that horizontal well drilling is more costly than the vertical drilling for it can cost over 300% more to drill one horizontal well than a vertical one. However, he reveals that the distance of penetration of the pay zone can go up to a distance of 10 kilometres. This technology if adopted in Turkana would go a long way preserving the grass vegetation that the livestock depend on, bearing in mind that this is the main source of economic activity in the region. Interviews with the local communities on their opinion regarding the biophysical effects of oil and gas exploration in the study area had 24% of the respondents observing that clearance of the vegetation was the main problem. A closer interrogation of this category of people indicated that they were mostly pastoralists whose primary source of income was pastoralism. There is a need, therefore, to adopt horizontal drilling in the consequential drilling activities in Turkana and other parts of Kenya to reduce on the ecological footprint. Restoration of the dry wells needs to be carried out within the internationally accepted period of 90 days((US Department of the Interior, 2017). Failure to take precautions will lead to the tragedy of commons scenario as discussed in section 2.5.4.On investigating the reason why such a technology had not been adopted in Kenya from the technical director of the main oil exploring company in Oil Block 13T South Lokichar Basin, the study established that the politics of economic gain dominated the process of decision-making since the cost of drilling 1 well using horizontal drilling is 3 times higher than the vertical drilling technology.This is consistent with the discussion of the political ecology theory in section 2.5.1.

Vegetation cover degradation has to a great extent catalysed inter-clan, transboundary and compensation related conflicts in the study area as discussed in section 4.4.15.

4.3.2 Oil and Gas Exploration and Waste Management in Oil Block 13T South Lokichar Basin

The study established that oil and gas exploration and drilling activities were generating a lot of waste materials which is consistent with (Namuyondo,2014).The main waste matter that was noted in the study area were the, drill cuttings and drilling mud waste. Numerous challenges were facing the management of these generated waste materials in Oil Block 13T South Lokichar Basin specifically the drill cuttings. A survey conducted to the locals revealed a state of lack of knowledge on the effects of the mentioned waste materials and considered some of them resourceful. This was evidenced by the use of the dense polythene liners material used in preparing mud pit for mixing of drilling fluids by some community members in building their Manyattas.These polythene liners according to Balgobin (2012) are quite hazardous and may cause contamination of the water and soil resources during the rainy seasons. An interview with the County Director of Environment revealed that the locals were acquiring illegally used chemical containers for domestic water storage. This illegal acquisition happens when the local communities in line with the local content requirement are awarded tenders by the Oil companies to handle general waste materials and end up taking the hazardous components of the waste.

The study established a major challenge in handling the large volumes of drill cuttings waste material generated across the various Well pads by the Oil companies. In addition, the drill cuttings from all the Well pads were being collected and dumped at one point in Twiga 1 Well pad.

According to the local communities, an awful smell was originating from the disposal site, and there were fears of water and soil contamination, an issue that was investigated by the study as shown in section 3.6.4. Initially, the drill cuttings were being stored in the reserve pits as shown in plate 4.10 and would be packed in trucks and transported for incineration as shown in plate 4.11. Plate 4.11 showing the drill cuttings being packed in bags in readiness for transportation



Plate 4.10: Drill cuttings temporary storage in a reserve pits in Twiga 1 (Source: Tullow BV Kenya Ltd., 2017)

for incineration in 2014. By this time the drill cuttings were manageable since the volumes were not significant.



Plate 4.11: Loading of drill cuttings in a truck for transportation to the incineration site (Source: Tullow BV Kenya Ltd. 2017)

Plate 4.11 shows the loading of the drill cuttings into trucks for transportation from Oil Block 13T South Lokichar Basin to Stoney Athi Nairobi a distance of 650 Km for incineration. The study established that due to the large volumes of the drill cuttings generated, the Oil companies were overwhelmed and started piling up the drill cuttings temporarily as they await transportation at Twiga 1 Well pad as shown in plate 4.12 below.



Plate 4.12: Reserve pit 7 full of drill cuttings in Twiga 1 (Photo: Researcher, 2017)

Plate 4.12 shows the reserve pit full of hazardous drill cuttings. Reserve pit 7 holds a capacity of 980 metric tons. The extra drill cuttings were stacked on the surface as shown in plate 4.13 below. This is an environmental pollution hazard.



Plate 4.13: Piles of drill cuttings beside reserve pit 7 in Twiga 1 (Photo: Researcher, 2017)

A section of the mud cuttings shows rainy mud formed after a sporadic rainfall that the locals claimed to have contaminated the surrounding grazing areas and underground water with hazardous materials from the drill cuttings. Plate 4.14 shows a torn polythene lining with sediments of evaporated silicate water used in preparations of drilling fluids. The evaporated silicate water according to Alvarez & Paranhos (2012) is associated with an awful smell of sulphur dioxide gas in the Well pads and the surrounding environment. The locals complained of the bad odour emanating from the site.

The images of the poor management of the mud cuttings in the study area formed the basis of chemical analysis of the drill cuttings to assess their potential effect to the environment.



Plate 4.14:Evaporation pond with silicate water used in preparing the drilling fluids (Photo:Researcher, 2017)

4.3.2.1 Heavy Metals Concentration of Reserve Pit 7 Drill Cuttings at Twiga 1 Well Pad in Oil Block 13T South Lokichar Basin

Due to some technicalities in analysing hydrocarbons and cost implications, the study focused on determination of heavy metal concentrations in the drill cuttings . The drill cuttings were sampled from reserve pit 7 as shown in plate 4.12 using the technique shown in figure 3.1. The findings were shown in Table 4.4 below.The results were presented as a mean positive or negative standard deviation of the triplicate analysis. From the data in Table 4.4 below,the results indicated a substantial concentration of toxic metals such as (Pb, Mn, Ni, Pb, Fe and Cu) and base metals such as (Ca and K), in the drill cuttings in the reserve pits.These findings of heavy metal concentrations in the reserve pits were consistent with Mbithe(2016) and Balgobin (2012) observations who found high concentrations of Ca, K, Fe Mn and Pb in the drill cuttings analysis.The study noted that the concentrations of the selected heavy metals detected by the XRF spectrometer in the reserve pit was in the order; Fe>Ca>K>Pb>Mn>Cu> Ni with their

average values being 70.74 ppm, 62.57 ppm, 8.14 ppm, 4.58 ppm, 1.58 ppm, 0.21 ppm and 0.05 ppm respectively. The concentration of Fe⁺ was higher when compared to the rest of the metals as shown in figure 4.11, a scenario that was depicted by Mbithe (2016) though it came fourth in her analysis, it was among the highly concentrated heavy metals. It is imperative to note that the average concentration of the metals varied across the reserve pits depth.

From top to the bottom of the pit the average concentrations of Fe, Ca, K, A, Pb, Mn, Cu, Ni, were: Top (81.76±10.9, 64.24±5.27, 9.02±1.19, 3.03±1.26, 0.94±0.59, 0.21±0.03, and 0.03±0.02), Middle (60.85±10.9, 56.66±5.27, 6.78±1.19, 5.14±1.26, 1.43±0.59, 0.19±0.03 & 0.05±0.02), Bottom (66.80±5.27, 65.88±10.9, 8.62±1.19, 5.27±1.26, 2.12±0.59, 0.24±0.03, and 0.08±0.02) respectively.

Table 4.4: Heavy metals contents in the drill cuttings from Twiga 1

Sample collection point	Coordinates	Sample No.	Parameters						
	022406.6N,0354256.2E		Cu	K	Ca	Fe	Mn	Ni	Pb
		1	0.17	5.91	60.00	33.70	0.59	0.02	0.74
TOP		2	0.17	12.18	35.50	69.15	1.12	0.02	4.30
		3	0.31	11.50	51.00	83.80	2.93	0.01	2.00
		4	0.17	7.30	90.30	38.30	1.97	0.09	2.17
		5	0.19	8.20	84.40	135.80	1.12	0.01	5.06
Top Average			0.21±0.03	9.02±1.19	64.24±5.27	81.76±10.9	0.94±0.59	0.03±0.02	3.03±1.26
		1	0.15	5.41	58.00	24.70	0.39	0.01	3.4
		2	0.17	8.31	73.00	70.15	2.91	0.01	3.34
MIDDLE		3	0.16	4.30	49.30	22.50	0.58	0.02	4.81
		4	0.26	12.8	74.00	99.20	2.72	0.19	4.9
		5	0.19	3.10	29.00	10.40	0.53	0.01	9.23
Middle Average			0.19±0.03	6.78±1.19	56.66±5.27	60.85±10.9	1.43±0.59	0.05±0.02	5.14±1.26
		1	0.22	9.21	80.00	100.00	1.60	0.04	0.94
BOTTOM		2	0.19	9.31	82.00	81.20	3.70	0.04	5.20
		3	0.21	5.30	53.4	26.80	0.64	0.06	5.60
		4	0.36	14.60	82	105.00	3.9	0.20	5.00
		5	0.24	4.70	36.6	16.40	0.78	0.04	9.60
Bottom Average			0.24±0.03	8.62±1.19	66.80±5.27	65.88±10.9	2.12±0.59	0.08±0.02	5.27±1.26
Mean STDV,S			0.03	1.19	5.27	10.9	0.59	0.02	1.26
Reserve pit average			0.21	8.14	62.57	70.74	1.58	0.05	4.58
WHO Recommended limits in a Reserve pit			2.00	No limits	100	0.30	0.50	0.02	0.01
USEPA recommended limits in Reserve pit			1.20	No limits	<100	0.30	0.05	0.05	0.01

Key: Findings were presented as the mean ± standard deviation of triplicate analysis written in red (Data Source: Field survey 2017)

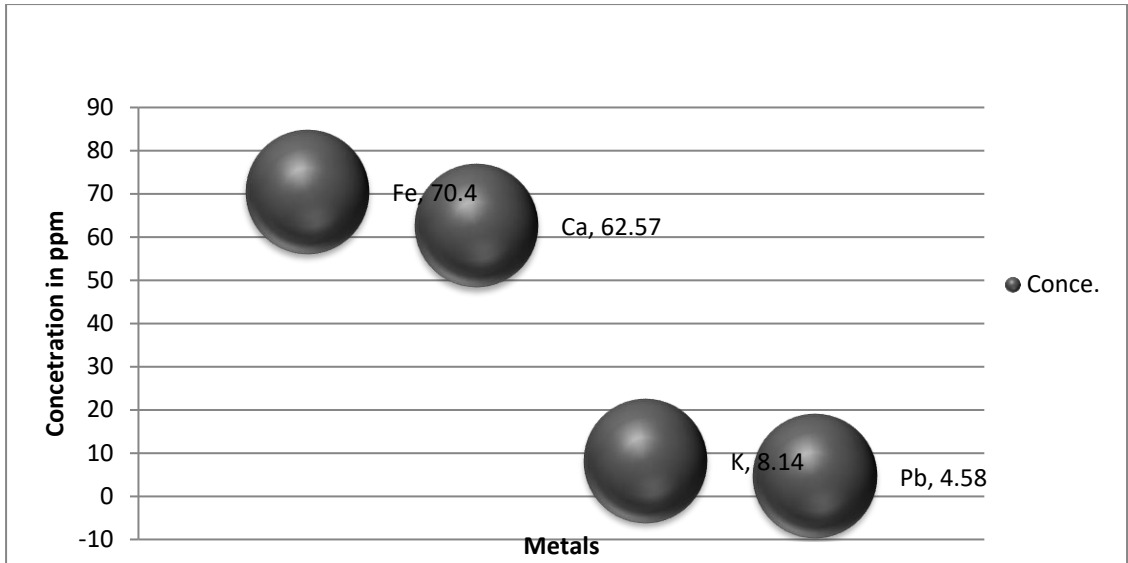


Figure 4.11:The most abundant heavy metals in the sampled drill cuttings from reserve pit 7 in Twiga 1 well pad (Source: Field survey 2017)

Except for K and Fe the concentration of the metals detected increased with increase in depth of the reserve pit a trend that was observed by Bybee (2002) and Mbithe(2016).Mn,Cu and Ni were the least abundant metals as shown in figure 4.12 below.

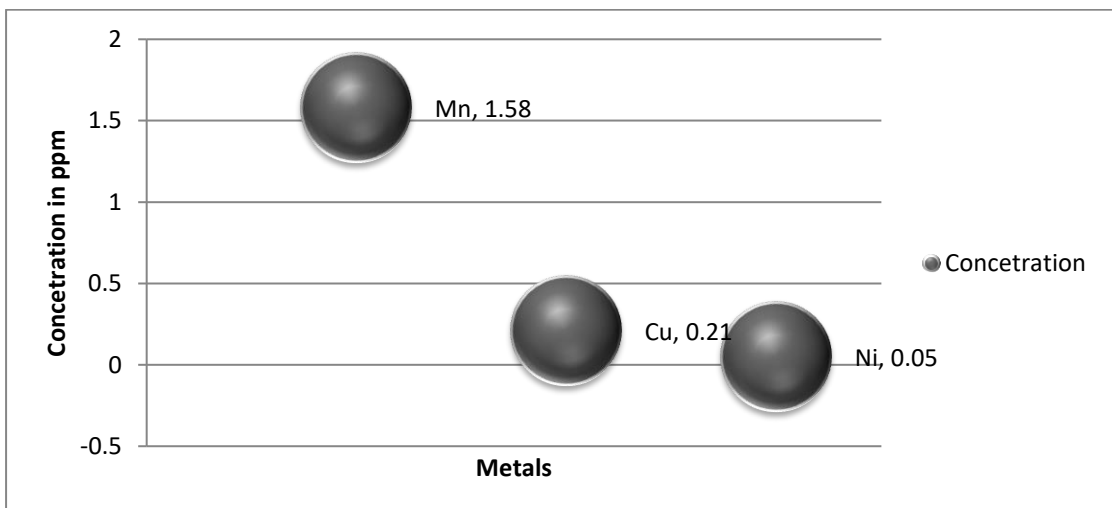


Figure 4.12:The least abundant metals in the sampled drill cuttings from reserve pit 7 in Twiga 1 well pad(Source:Field survey, 2017)

On average among the four most abundant metals it was only Ca that was within the international recommended standard limits by bodies such as WHO, FEPA and USEPA for selected heavy metals concentration within a reserve pit. Fe and Pb were above the recommended limits as shown in figure 4.13

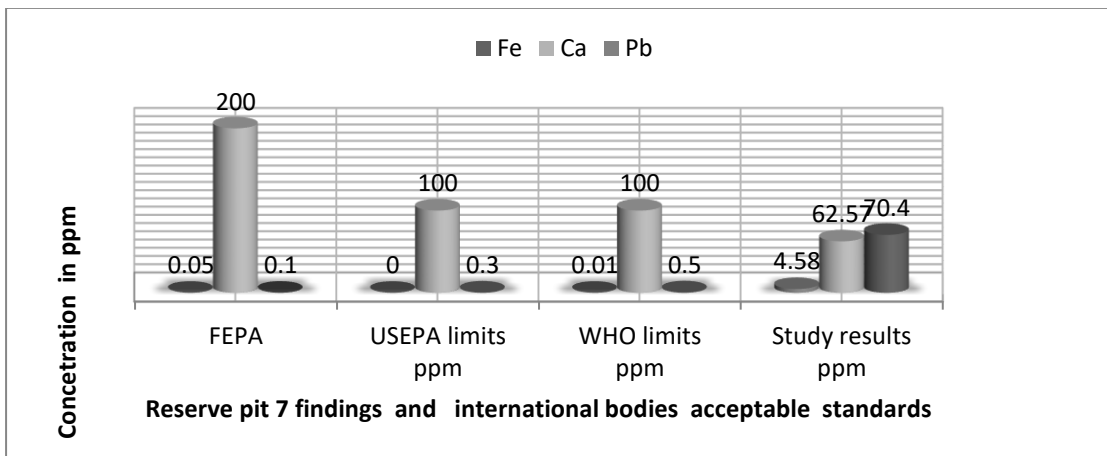


Figure 4.13: Most abundant heavy metals concentration in the sampled drill cuttings from reserve pit 7 in reference to internationally recommended limits (Source: Field survey 2017)

Among the least abundant metals, the concentration of Mn was higher than the recommended limits while Ni and Cu were within the limits as shown in figure 4.14

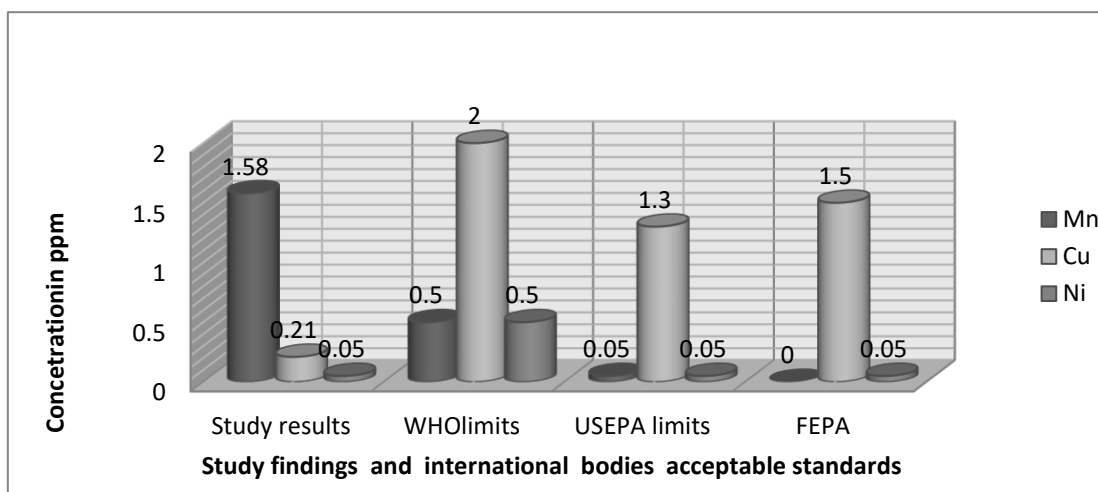


Figure 4.14: Least abundant heavy metals concentration in the sampled drill cuttings from reserve pit 7 in reference to the internationally recommended limits (Source: Field survey 2017)

Table 4.4.1 below shows a comparative analysis of the current study with the previous studies. In all the three studies, Ca, Ni, Fe, Mn, Pb, and Cu were detected. Fe was the second most abundant metal after Ca in the three studies while Ni was the least most abundant metal of them all. This shows similar characteristics of reserve pits.

Table 4.4.1: Comparison of the current study and previous studies reserve pits selected heavy metals concentration

	Ca	Ni	Fe	Mn	Pb	Cu
Current study	62.57	0.05	70.4	1.58	4.58	0.21
Mutua(2016)	1193	0.26	381.46	5.58	1.749	1.15
Kinigoma(2001)	169.6	0.09	20.0	2.23	<0.001	0.029

(Source: Mbithe,2016 and Kinigoma, 2001)

Poor disposal of drill cuttings automatically leads to pollution of water,soil and air
The study assessed the physical chemical properties of the community borehole water in the study area to determine the probability of borehole water pollution.

A comparison of the findings with previous studies assesments done for the same boreholes before oil and gas exploration activities began indicated a significant variance as shown in Table 4.5.Although the high levels of selected heavy metals contents in the drill cuttings material may not be totally attributed to the variation of the heavy metals concentrations and physical characteristics changes, of the borehole waters, their effects cannot be ruled out.This is because studies done all over the world have shown that poor drilling waste management contaminates both underground water and the surrounding soils environments.Ramirez(2009) notes numerous cases of

reserve pit contamination worldwide. In Mexico, the New Mexico Environmental Bureau, since its inauguration in the mid-1980s, has documented more than 6,700 cases of reserve pits causing water and soil contamination in the State with 557 of those cases resulting into groundwater contamination (Anderson, 2003). This observation was also made by Balgobin (2012) who noted that heavy metals and hydrocarbons from poorly managed drill cuttings had contaminated both underground water and surface water in Niger Delta in Nigeria. Mbithe (2016) warned that drill cuttings waste materials might cause water and soil pollution in Lokichar Basin. A study done in Twiga 1 well pad on the impact of the drill cuttings on the soil by SGS indicated that the levels of selected heavy metals that is Zinc, Iron, Sodium, Magnesium, Copper and Calcium were much higher than the levels before the oil and gas exploration began in 2012. See appendix 7.11 for comparative analysis. Soil contamination would automatically lead to underground water contamination through infiltration. This study in addition observed intense erosion of the piled up drill cuttings materials by the surface runoff, as shown in plate 4.15 below, and this is a hazard to the underground water and soil contamination.



Plate 4.15: Tunnels of eroded mud cuttings by the surface runoff (Photo: Researcher, 2017)

The study endeavoured to find out why the Oil companies had not been able to adopt an advanced technology method in the management of the drill cuttings on site as it is the case in countries such as Ghana and even developed countries such as Norway. The study established that the major hindrance was the Kenya environmental legislations on the management of hazardous materials generated from oil and gas exploration activities as discussed in section 4.2. The current Kenya environmental laws do not recognise technologies such as Thermal Desorption Unit and Phytoremediation in the management of hazardous waste material. Thermal Desorption Unit (TDUs) is a technology used in recovering of oil-based drilling fluids from drill cuttings all over the world. Okeke & Obi (2013) explains that TDUs heats the drill cuttings that have been contaminated with the drilling fluids indirectly at 4000 degrees Celsius and recovers the drilling muds but it does not cause the destruction of the harmful chemicals such as heavy metals and therefore it needs to be complemented with bioremediation and phytoremediation technology. Phytoremediation is a technology that uses plants organism and related soil microbes to manage the high levels of heavy metals from the drill cuttings. It is somewhat a current technology and is alleged to be economical, compelling, original, sustainable, and uses solar technology with good public acceptance. New effective metal hyperaccumulators are being discovered for applications in this new technology. According to Shevyako(2011), *Amaranthus sp.* have been found to hyperaccumulate Nickel. *Agrostis tenuis* and *Festuca rubra* grass species have been found to phytostabilise Copper, Zinc, Lead and Zinc and lead respectively. Sunflower and spinach have been noted to phytoremediate lead from contaminated water and soil (Raskin & Ensley, 2000). The drilling fluids can be reused, and the remaining solid can be used in agriculture. According to Abha & Singh (2012), bioremediation uses naturally modified organisms to decompose and feed on

the hydrocarbon materials making them suitable for use as organic fertilizers. However, in addition to the restrictions on the technologies mentioned above by the Kenyan law, there lacks human capacity to use the technologies and this poses another challenge to drill cuttings hazardous waste management. An interview with the Oil Company lead environmentalist revealed that high-temperature incineration was the only technology the companies were applying in the management of the drill cuttings. They however, lamented that the cost implication was quite high since the Oil companies according to the production sharing agreement with the government had to contract a private firm to handle the task. As aforementioned, the drill cuttings volumes generated were quite massive, and by the time this study was carried out, the incinerators existed in Nairobi, and this ballooned the cost of transporting these hazardous waste matter for incineration. The study further revealed that the hazardous drill cuttings material were being transported for a distance of 650 kilometres by road to the incineration point.

The lead environmentalist of the main Oil operating company in Lokichar Basin further explained that the transportation of the drill cuttings was being done by use of specially licensed trucks to the incineration sites in Nairobi. The study established that the approach being used in the management of the drill cuttings waste material was not sustainable. This is because the road transport that was used in ferrying the mud cuttings for incineration was risky due to spillage. On average, the truck would take a minimum of five days to get to the incineration point from Lokichar which may not be a very effective method. The interview further established that a waste tracking form is usually filled upstream and it is generally signed by a receiver who ascertains the receipt of the specific waste materials collected from the collection site. The tracking form is a legal document by National Environmental Management Authority, and all waste

transporters have to fill in the details. The essence of this form is to help in taking responsibilities just in case of spills or pollution while the waste is on transits. The process depicts that there is a possibility of a spillage happening and in such situations, even people living far from the oil and gas exploration sites are at risk of contamination. The fact that the Oil companies depend on global oil prices to pay the private drill cuttings waste materials handlers is another challenge. This is depicted in section 4.4.5 where the private companies contracted by the Oil companies retrenched their employees since the Oil companies could not afford to pay them. The study also learnt that the drill cuttings waste collector boycotted the task of waste collection due to some arrears and this led to piling up of the drill cuttings waste materials. For sustainable environmental management to be realised in Oil Block 13T South Lokichar Basin, it is imperative for the country to develop laws and policies that would allow management of the drill cuttings waste materials on site. This means, legalisation of technologies such as TDU and phytoremediation techniques in drilling waste management. The poor management of the drill cuttings does not only pose a health threat as discussed in section 4.4.3 but it has caused a lot of social instability in the study area.

A survey conducted to the local communities and an interview with the County Director of Environment revealed that the decision of the Oil companies to settle on Twiga 1 site as a drill cuttings waste disposal site was not consultative as noted in section 4.4.13. Majority of the respondents felt that they were not engaged enough by the Oil companies. As a result, the local communities blocked the accessibility of Twiga 1 well pad from April 2017, where the drill cuttings were being disposed and this paralysed part of the operations of the Oil companies which is consistent with Fallet 2010 over Niger Deltas chaos. There is a need therefore to adopt a sustainable waste

management strategy for both social and biophysical environmental management in Oil Block 13T South Lokichar Basin.

4.3.3 Oil and Gas Exploration and Atmospheric Environment Pollution

An interview with the lead environmentalist of the main Oil company operating in South Lokichar Basin, established that gas flaring is part of oil and gas exploration process and it intensifies once oil production begins. The flared off natural gases is usually a byproduct of crude oil from reservoirs in which there is a mixer of oil and gas. Gervet(2007) notes that gas flaring involves the release of hazardous hydrocarbon gases mostly methane, which is one of the strongest greenhouse gases, Sulphurous oxides and Nitrogen oxides into the atmosphere. The gases released during gas-flaring blends with the moisture and other forms of precipitation in the atmosphere to form acid rain.

An interview with an officer from the Meteorological Department of Kenya indicated that these flares do raise the temperatures of the surroundings causing a micro-climate. This explanation relates to complains from the locals that since the oil and gas exploration activities began, the temperatures of the area have changed from the normal, though this study can not fully substantiate this, it is an issue that may need to be investigated further.



Plate 4.16: Gas flaring from a well testing in Oil Block 13T South Lokichar Basin (Photo: Researcher, 2017)

The officer noted that these emissions are linked to changes in the atmospheric temperatures because of their role as greenhouse gases. An analysis of average annual temperature data of the study area since 1990 indicated a consistent rise in temperature since the year 2012. The trend in temperature rise may be attributed to emission activities in the oil fields, since according to the 2012 EIA report by Earthview Consultancies, drilling activities were to cause greenhouse gases that could have led to increased atmospheric temperature. Clearance of vegetation and dry forest vegetation too may have resulted in changes in atmospheric temperatures since vegetation act as carbon sinks. The fact that the Oil companies have been depending on diesel generators as the main source of energy (Tullow, 2017), Carbon dioxide gas from these diesel generators may have resulted to increased greenhouse gases hence resulting

to changes in temperatures in the study area. See the trend of the temperature changes from 1990 to 2017 in figure 4.15 and figure 4.16 below.

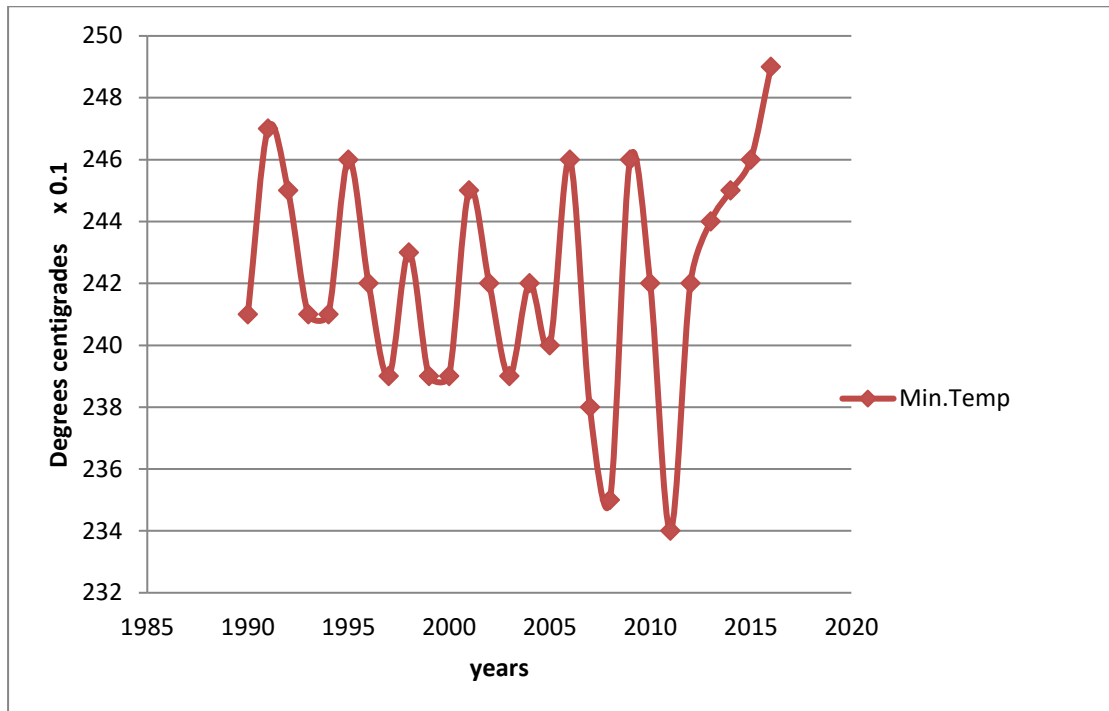


Figure 4.15: Trend of minimum temperatures of the study area from 1990 to 2017 (Source: RoK, 2017)

Figures 4.15 and figures 4.16 show the trend of temperature variability in the study area. Although this study may not with certainty attribute the slight variation in both minimum and maximum temperatures to the flaring of the gas shown in plate 4.16 and other particulate matters resulting from exploration activities, there is a possibility of them being key contributing factors. The mean annual range difference in temperatures for instance between the maximum and the minimum temperatures between 2008 and 2010 which was before the oil and gas exploration activities began was 11.2°C .

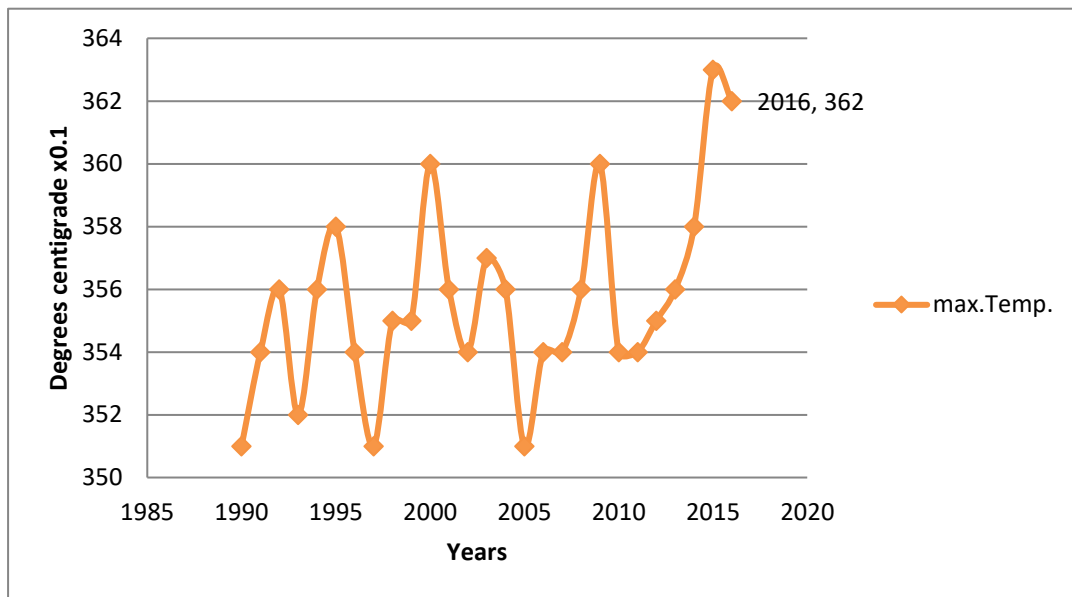


Figure 4.16: Trend of maximum temperatures in the study area from 1990 to 2017 (Source: RoK, 2017)

The mean annual range difference in temperatures between 2012 and 2016 was 11.3 degrees centigrade. These figures show a slight increase in temperatures in the study area, which is consistent with the study done by Ismail (2012), Ajugwo, (2013), Kadafa & Ayuba (2012) who noted that appraisal wells gas flaring leads to temperature increases in the surrounding areas due to the emission of greenhouse gases. The findings also affirm the views of the 20 % of local communities' respondents shown in figure 4.1 regarding the temperature changes in the area since the oil and gas exploration activities began. There is a need to minimise on gas flaring or use technologies that can harvest and profitably make use of these gases such as the flare recovery unit technologies used in Norway as noted by Smith & Seefeldt (2013) in section 2.3.3 if sustainable atmospheric temperatures and air emissions are to be achieved. Sustainable management of unwanted gases is vital because with oil and gas exploration, little flaring gets carried out, but flaring will intensify with oil production

hence the need for early precaution measures. Mall (2009) notes that Devon Energy used up \$15 000 to capture methane gas discharges from a well in 2009 and traded the methane for \$35,000. The Government of Kenya and the Oil companies must ratify the World Bank Group 'Zero to Routine flaring 2030 initiative' which will call for the development of legislations to meter and monitor and measure the amount of gas being flared and their composition and annual reports submitted to the world bank on top of the flare recovery technology.

4.3.4. Oil and gas exploration, Dust and Light Pollution

A survey with the local communities shown in figure 4.1 (where n=361) indicated that 20% of the locals felt that dust emission was a significant problem caused by oil and gas exploration activities in Oil Block 13T South Lokichar Basin. The local communities asserted that the activities have been generating a lot of dust emissions into the atmosphere that a times affect the feasibility and this dust ends up settling on their facilities. The Oil company field environmental officer revealed that the challenges of water shortage in the study area have negatively impacted on dust mitigation especially during road and campsite excavation activities. However, she noted that the Oil company was effectively managing the dust emanating from the well drilling using both dry and rainy dust management systems. The dust pollution in the oil and gas exploration fields in Oil Block 13T South Lokichar Basin is consistent with the study done by Mikic *etal.* (2017). They noted that dust is a significant by-product of oil and gas exploration activities and adequate water supply is always a reliable management system of the pollutant. This is consistent with Askarova & Mussagaliyeva (2014) who noted that construction of Well pads, access roads, the earthwork and site clearance during oil and gas exploration activities do emit a lot of

dust to the ecosystems. The locals also complained of light pollution, especially during the night from the flaring of gases during well appraisals as shown in plate 4.16. The study established through a group discussion with the local elders at Kapese village that light pollution was exposing the biotic component around the gas flaring area to a 24-hour light.

The study established that the exposure to the light affected the animals and humans night times and diurnally patterns. The impact had resulted in fleeing of wild animals, and even affected the sleep patterns of human beings in the surrounding areas. These findings are consistent with Farina(2010) who noted that light from flaring and drilling installations creates an environment where the continuous lights affect the circadian rhythm of animals and humans. This calls for the Oil companies to endeavour to be carrying out their flaring and drilling activities in the daytime, the Oil companies need to light the drilling derrick by lights facing downwards and by use of amber light instead of blue light Lee(2018) to avoid the light pollution on the fauna communities in the area. The study established that as flaring intensifies in the production stage, this form of pollution will deepen, hence the need of sustainable mitigation measures. The water problem to help in the management of dust needs to be addressed through deep aquifer water borehole drilling or pumping water from river Turkwel as explained in section 4.4.2.

4.3.5 Oil and Gas Exploration and Environmental Noise Pollution

The study established that noise pollution was another major challenge resulting from oil and gas exploration activities within Oil Block 13T South Lokichar Basin. As indicated in figure 4.1 10% of the respondents pointed out that their major concern was the noise pollution emanating from the oil and gas exploration activities. According

to the natives, the primary source of the noise pollution was the noise produced by air compressors, diesel generators, vehicles, sirens, drilling engines, air compressors, generators, and warning signals. However the lead environment expert from the leading oil and gas exploration company in Oil Block 13T South Lokichar Basin countered the locals assertions by noting that the seismic and drilling contractors applies some noise reduction methods such as the use of noise subjugation techniques and devices such as screens, enclosures, and silencers in addition to regular maintenance of the equipment. The study findings on the noise pollution in Oil Block 13T South Lokichar Basin is consistent with Greer(2013).He noted that oil and gas exploration activities cause noise pollution that may lead to stress of the locals.There is a need to implement noise reduction mechanisms such as the use of noise subjugation techniques and devices such as screens, enclosures and silencers by the oil exploring companies as failure to do so may lead to conflicts with the locals in the sequential oil and gas exploration and production.

4.3.6 Potential Impacts of Oil and Gas Exploration on Underground Water Contamination in Oil Block 13T South Lokichar Basin

As shown in figure 4.1 , 36 % of the locals lamented that poor management of the mud cuttings and drilling fluids in the area had polluted their community water boreholes.The study observed a variation on community boreholes water quality pre and post commencement of oil and gas exploration.From the data presented in Table 4.5 below, the PH of the samples collected had slightly decreased compared to the levels detected before the oil and gas exploration activities began in 2011. The average PH for the four boreholes in the year 2011 was 8.23 while the mean P.H of the four boreholes in the year 2017 was 7.96.This represents a decline, a factor that may be

attributed to the addition of acidic components into the underground water. The study attributes the source of the acidic components to be drilling waste materials and acidic rain formed from gas flaring as noted in section 4.3.3. These findings are consistent with the conclusions made by Cline (2008) that gas flaring during oil and gas explorations activities leads to acidic rain formation, that end up lowering the P.H of soil and water ecosystems. The source of the acidic components may as well be from the acidic salts that form from heavy metal pollutants as noted by Asche & Lead (2013) and Odari *et al.* (2015) who identified Barium Sulphate as the primary causal agent, an element discussed in section 2.3.2.1.

Though there is no cause for alarm, since the P.H of the water is within the World Health Organization limit for drinking water of 6.5-8.5, it is imperative to ensure proper management practices of the waste material emanating from oil and gas exploration activities are ensured to caution for the subsequent oil and gas exploration and production stage. These waste materials either in gaseous, liquid or solid forms needs to be managed sustainably for the safety of the biotic lives. This appeal is substantiated by the fact that the P.H of the water samples seems to be decreasing and if it falls below 6.5, then the waters in the area will not be safe for human and animal consumption. Also, the mean water Turbidity increased from 1.06 NTU in the year 2012 to 5.68 NTU in the year 2017. High Turbidity may have resulted from increased seismic and excavation activities around the oil fields as this concurs with the work of Ayuba (2012) who documents the same factors being the significant agents of Turbidity change in oil and gas exploration sites. He notes that among the many causes of increased water Turbidity is the disposal of waste material into the water body. The average water Turbidity of the sampled boreholes was 5.68 NTU, and this surpasses the World Health Organisation limit of 5NTU per litre.

According to Sumi (2005), total dissolved solids come about due to dissolved hydrocarbons, selected heavy metals, acidic salts, volatile organic compounds and other inorganic compounds. This study noted that the TDS increased from 292 mg/L in 2012 before the oil and gas exploration activities began to 1145 mg/L in 2017. As indicated the primary source of these dissolved solid materials is the heavy metals, Sulphates salts, Bicarbonates and other hydrocarbons. These hydrocarbons include grease, oil, and dissolved organic compounds such as Naphthalene, Phenanthrene, and Pentachlorobenzene, Toluene, and Pentachlorophenol. One primary source of the noted increased TDS in the underground water could be infiltration of surface runoff that has dissolved matters from poorly disposed of untreated drill cuttings or contamination by the produced water during well drillings. This argument is supported by the fact that the levels of TDs as noted in Table 4.5 were quite low before exploration activities began. The assertion also concurs with Mbithe (2016) who pointed out that the waste material generated during oil and gas exploration leads to increased total dissolved solids in water. The levels of the TDS was way much above the World Health Organisation limit of less than 1000mg/L. This situation if not managed may lead to health challenges to both animals and humans due to the specific components such as Benzene and other hydrocarbons and heavy metals whose in excess levels are toxic. Bioaccumulation of Benzene and other hydrocarbons as noted by Ajugwo (2013) has been linked to colon and respiratory infections including cancer.

The Atomic Absorption Spectrophotometry used in the analysis of the water sample failed to detect some heavy metals such as Copper, Magnesium, Barium and Lead. The levels of Iron were way much above the World Health Organisation of 0.3mg/L since the analysis recorded the average levels to be 1.0425 mg/L. The high levels of Iron are attributed to the drilling activities in the study area. This argument is supported by the

fact that, by the year 2012 before the oil and gas exploration activities began, the water samples from the study area did show levels of Iron which were less than 0.01. The basis of the argument is in agreement with Knez *et al.* (2006) who reported that drilling muds are typically combined with Barite to increase their density during drilling activities and that, these Barite have a lot of impurities inform of selected heavy metals and Iron is a crucial component.

The level of Iron is alarming because according to Grazuleviciene *etal.*(2009), ingestion of Iron by animals and humans produces free hydrogen radical, that attack the DNA, and this causes damage to the body cells, mutation and malignant diseases such as cancer of the colon and respiratory systems. The average levels of calcium in water samples of the boreholes indicated a decline from an average of 20.19 mg/L in 2012 to 13.29mg/L in 2017 while the average levels of Magnesium increased slightly from 18.21 mg/L to 31.35mg/L.Both metals level is within the World Health Organisation limits of < 100mg/L and <50mg/L respectively.The water samples also did show a slight variation in average levels of Potassium, but in both cases, the levels were below 5mg/L.Potassium has not been reported to have any significant side effects if overdosed in the human body and thus there is no limit for it's in drinking water from the World Health Organisation.

The most striking element identified in the samples of the four boreholes that were sampled was Nickel.The previous studies, that were done before the oil and gas exploration activities began in 2012 recorded an average levels of Nickel that was <0.01.The average levels detected by this study in 2017 was 0.46 mg/L.This concentration of Nickel in drinking water is way much above the World Health Organisation's limits of 0.02mg/L. The fact that the Atomic Absorption Spectrophotometry detected average Nickel levels of < than 1 in the samples collected

before the oil and gas exploration activities began raises the bar of speculations that, oil and gas exploration activities may have contributed to these levels. This assumption concurs with Mbithe(2016) who noted that drill waste materials are very rich in selected heavy metals such as Nickel and if not managed correctly they ends up polluting soils and water aquifers.

Short and prolonged exposure to Nickel has serious health implications to both animals and human beings according to Duda-Chodak & Blaszczy (2008).They noted that exposure to Nickel is highly associated with dermatitis skin infections, nasal and lung cancer infections and other respiratory problems.The findings of the presence of heavy metals in the water samples from the study area is consistent with the findings of Jerry (2008) who noted that,the use of Barium Sulphate as a density enhancing agent for the drilling fluids and pressure balancing agent has been the primary source of heavy metal pollutants in soil and water.He adds that Barite has a lot of impurities of heavy metals and if the surface runoff washes these impurities or form leachate from the mud cuttings, they end up polluting the water or the soil resource.

From these findings, it is imperative to state that proper management of the causative agents of these elements, such as drill cuttings, flared gases, and drilling fluids is important.

Table 4.5: Results of the heavy metals concentration in the sampled water from the study area in comparison with previous studies results (Source: EIA 2012 and Fieldwork 2017)

Parameters	DATA FROM WRA 2011				DATA FROM NEMA, 2012 EIA				STUDY SAMPLES RESULTS in 2017				WHO limits
	In ppm & NTU for Turbidity												
Boreholes	Acs	Lokichada	Saleyad	Nakukulas	Acs	Lokichada	Saleyad	Nakukulus	Acs	Lokichada	Saleyad	Nakukulus	
pH	8.26	8.32	8.22	8.34	8.17	8.36	8.19	8.37	8.09	7.71	8.06	8	6.5-8.5
Turbidity	5	0.1	3	<0.01	0	0.12	0.2	0.1	6	6.3	5.5	4.9	5
Fe	0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.11	1.17	1.5	0.39	0.3
Ba	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	ND	ND	ND	ND	0.3
Mn	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	ND	ND	ND	ND	0.1
Cu	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	ND	ND	ND	ND	2
Ca	31.2	4	29.3	6	37.6	9	36.4	8	12.25	15	16	9.89	<100
Mg	18.97	7.34	16.4	5.37	37.45	12	39.6	8.37	45.4	32.3	28.2	19.5	50
K	0.4	2.4	0.2	1.9	3.9	1.5	3.4	1.9	2.4	2.92	6.06	3.59	No limit
Ni	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.27	0.63	0.58	0.37	0.02
Pb	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	ND	ND	ND	ND	0.01
TDs	12.9	32.1	14.2	25.4	391	750	388	718.6	1060	1020	1473	1025	<1000

4.3.7 Comparison of the Concentration of the Heavy Metals in the Soils around Twiga 1 Reserve Pit 7 Pre and Post Oil and Gas Exploration Drilling.

The concentration of metal such as Barium in the soil sample around the reserve pit as shown in appendix 7.11 was 1200 ppm above the Dutch intervention value(D.I.V) of 920 ppm for the 2017 analysis, and a similar case was depicted in Lead metal which was 1768 ppm above the 530 ppm recommended Dutch intervention value. The 2012 baseline information for these metals was not available for they were not detected. The 2017 report by SGS did show that the values for Zinc and Copper were(32.5 and 17.95 ppm) which were all above the values recorded in 2012(2.36,0.04 and 3.29 ppm) respectively as shown in appendix 7.11. Other metals that were detected in the analysis in 2017 but they were not detected in 2012 soil analysis were, Nickel(7.9ppm), Mercury(< 0.05) and Chromium(13.8 ppm).

Although these values were within the Dutch Intervention soil values, they were above the values of the soil analysis done before the oil and gas exploration took place. The study established that the nearer the soil sampling point was to the mud cuttings reserve pit, the higher the concentration of the heavy metals. Appendix 7.11 shows soil samples(S7, S8, S9, S10, and S12), collected 20 meters outside the well pad fence had less concentration of heavy metals as compared to samples(S14, S15, S16, S17, S18 and S 19) that were collected next to the reserve pit . This suggests that there is a possibility of soil pollution that could be linked to the mentioned water pollution.

4.3.8 Cronbach's Alpha Intra-reliability Test on Oil and Gas Exploration Effects on the Biophysical Environment

Intra-reliability Cronbach Alpha test for the attitudes of the locals on oil and gas exploration effects on the biophysical environment was shown in Table 4.6 below.

The study observed that the locals felt that poor disposal of drill cuttings; vegetation clearance, noise pollution, increased particulate matters and dust were the major biophysical environmental problems they were experiencing since oil and gas exploration activities began. The Cronbach Alpha coefficient for the ranked effects was .728, suggesting that the effects have relatively high internal consistency. A reliability coefficient of .70 or higher is considered acceptable in most social science research situations.

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items			N of Items
.728	.636			4
	Exploration has caused pollution from drilling waste	Exploration has resulted in clearing vegetation	Exploration has resulted in noise pollution	Exploration has caused an increase in particulate matter/dust in the atmosphere
Exploration has caused pollution from drilling waste	1.000	.522	.294	.172
Exploration has resulted in clearing vegetation	.522	1.000	.525	.383
Exploration has resulted in noise pollution	.294	.735	1.000	.457
Exploration has caused increase in particulate matter/dust in atmosphere	.172	.383	-.457	1.000

Table 4.6: Cronbach's Alpha Intra-Reliability Test

4.4 Oil and Gas Exploration Effects on Socio-Economic Characteristics of the Locals in South Lokichar Basin

4.4.1 Introduction

Oil and gas exploration in Oil Block 13T South Lokichar Basin, Turkana County has led to several socio-economic changes in the area and among the locals. This is consistent with the study done by Rourke & Connolly (2003). Turkana County lies under ASAL areas of Kenya and majority of the locals depend on pastoralism as their primary economic activity. Until 2015, social and physical infrastructures such as electricity, water, adequate health facilities, education facilities and road infrastructure had not been within the reach for the majority of the locals in the study area (Schilling & Locham, 2015). This study established that oil discovery in Oil Block 13T South Lokichar Basin had started to attract these development projects from the governments and investors. However, the latch is in ensuring sustainability in the management of the developments arising from this new oil and gas exploration venture. In addition, several negative effects had resulted such as population influx, land displacement, conflicts among others.

4.4.2 Oil and Gas Exploration and its Effects on Water Provision in Oil Block 13T South Lokichar Basin

Water has been a scarce resource in Turkana County. The pastoral communities move for long distances in search of water for their livestock. The main river in Turkana County is river Turkwel whose tributaries river Wei Wei passes through the study area and whose waters are seasonal. The river rejuvenates typically only during the rainy seasons, and a dry river course and evergreen riverine vegetation are all that is visible

during the dry seasons, which dominates most of the year. Shallow underground aquifers are the primary source of water for domestic use and even for the industrial use according to an interview with the County Director of Environment. The study established that the NGOs and the County Government by 2012 had developed a total number of 36 boreholes in Turkana South Sub-County with only 7 of these being located within Lokichar ward, the Water pans were only 3, Shallow wells were 24 and springs were 3. The study established through document review that these water points would adversely be affected by climatic factors and some such as the shallow wells and water boreholes would run dry. The average return distance to livestock watering points ranged between 10-20 kilometres for the livestock use.

The animals which comprises of goats, sheep, cattle, donkeys and camels but mostly goats used to be watered at intervals of 1 to 2 days with the waiting time ranging from 6 to 24 hours. The average distance to the pumps for domestic consumption was 3.9 kilometres one way with a waiting time on the queue of up to 6 hours (CGT, 2017). An interview with Lead environmentalist and the Director of Communications of the main Oil company operating in Oil Block 13T South Lokichar Basin in addition to the ground trothing done by this study established that the Oil companies had drilled 9 more water boreholes in Oil Block 13T South Lokichar Basin. These new boreholes constructed by the Oil companies to supplement the ones being done by the County Government are; Kagitankori, Karoge, Katilia, Lokapel, Nalemkois, Nakare, Lochwarengan, Katilu, Kokito, Kakalel. Five of these boreholes; Karoge, Nalemkaise, Nakaalei, Kokito community borehole and Kagitankori boreholes are located in Turkana South. In addition to the three existing water pans, the Oil companies had constructed 3 more Water Pans in Turkana South that is Nakaalei, Kaaroge Ewoi and Nalemkaise. In Turkana East, two more water pans which are Lokichada and Lokwamsing have been

constructed and these Water Pans have helped to reduce the distance covered by the pastoralists in search of water. In addition, the Oil companies had installed 30 water tanks with a capacity of 10,000 litres at various points of the basin by December 2017 as evidenced by the photo shown in plate 4.17 below. The Oil companies have contracted local water distribution companies that refill the various established water storage tanks every morning. In addition, the Oil companies have employed many young people as drivers or manual workers for filling and emptying the storage tanks. The study further observed that the Oil companies supplement water from their boreholes through purchasing water from the indigenous community boreholes. See the photo of the water tanker contracted by the Oil companies to refill the water tanks in appendix 7.14. As a result of these interventions on water provisions by the oil companies, the study established that the distance to fetch household water had reduced with 72 % (n=361) of the locals saying that the walking distance to the water point had reduced to a range of 1.1-1.5 kilometres one way and the waiting time had reduced to 30 minutes. 20% of the locals indicated that the distance to the water point was between 1.5-2.5 kilometres one way with a waiting time of 1 hour. 5 % of the locals indicated that the distance ranged between 2.5-3.5 kilometres with a waiting time of 2 hours for domestic household water.

The rest of the population indicated that they had not experienced any difference in terms of distances and waiting time since oil and gas exploration activities began. Since watering livestock in the areas mostly happens in areas with water pans the locals noted that the distance for watering livestock had declined to 3.9 kilometres one way and the waiting time had reduced by 49% to an average of 3 hours. The study conducted surveyed the locals' attitude in regard to adequacy of the water provided in the study area and the locals observed that they had noted a tremendous improvement regarding

water provision and since the Oil companies started their exploration activities in the area. The study ranked the views of the respondents on water provision on a Likert scale .40% of the respondents believed that they had adequate water since exploration activities began compared to 12% who felt they had adequate water before the exploration activities began. 30% of the respondents believed the water and sanitation levels were moderate after the oil and gas exploration began compared to 22% who had the same feeling for the levels of water and sanitation before the oil and gas exploration activities started.20% of the interviewee believed that the water and sanitation services were not adequate at all after the oil and gas exploration began compared to 28% who felt the water was not adequate at all before the oil and gas exploration began. 10% of all the interviewees said that the water and sanitation services were poor after the oil and gas exploration activities began compared to 38% who felt that the services were poor before the oil and gas exploration activities began.See the responses of the locals attitudes in figure 4.17 below

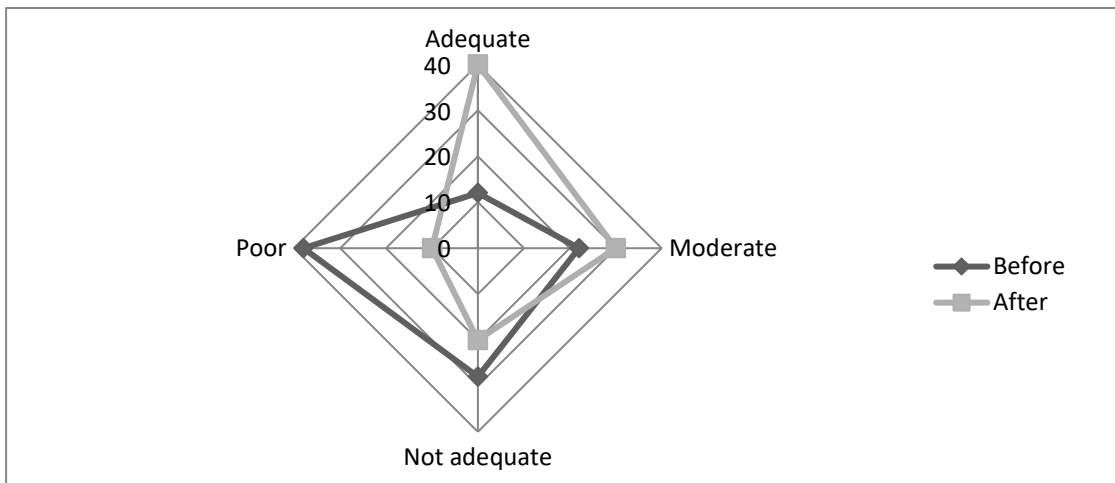


Figure 4.17:Locals’ opinions in percentages on water provision pre and post commencement of oil and gas exploration in study area(Source:Field survey, 2017)



Plate 4.17: Locals fetching water from the water storage tanks installed by the Oil companies at Kapese village (Photo: Researcher, July 2017)

Plate 4.17 above shows the locals watering their flocks. The focused group discussion with the local elders revealed to the study that the water interventions within the area had contained long distance movement of the pastoral communities in search of the resource.

However although the initiative to install and refill the water tanks for the pastoral communities is an excellent concept, its sustainability is not feasible. The ability of the oil companies to sustain this strategy lies in the performance of the global oil and gas prices. In case of a drop in oil prices then the Oil companies may not be able to buy water from the supplier and even to pay the water trucks refilling the installed tanks. The study also learnt that in July 2018 the locals conflicted with the Oil companies lamenting of the oil companies not giving them jobs and tenders and they blocked the roads hampering the operations of the companies. In return, the Oil companies curtailed the refilling of the water tanks until the conflicts were resolved when the National Government intervened. The study also learnt that the water provision is only happening

in Turkana South and East Sub-counties where the oil and gas exploration is intensively being carried out.

This means that the water problem is still persistent in Turkana West, Part of Turkana Central, Loima, Kibish and Turkana North Sub-County where the distance to and from the nearest water points are diverse depending on the areas but on average is between 5-10 kilometres (OXFAM, 2015). In urban centres and some market places, several water users associations have succeeded to pipe water nearer to the settlements thus decreasing the distance to the next water points. However, in far flung areas like Kibish and other sub-counties mentioned the distance covered is considerable higher ranging from 10-20 kilometers. There is a need for a more sustainable strategy in fighting the water glitches in the region.

Several options can be adapted to manage water problem in the area. These consist pumping water from river Nile in Uganda, local groundwater; Turkwel Dam; distant groundwater or pumping water from Lake Victoria. Digging deep aquifers boreholes from the local underground and pumping water from Turkwel dam are the most appropriate options. A feasibility study done by Tullow BV. Kenya Ltd. in 2013 indicated that a deep aquifer in Turkana Oil Block 13T South Lokichar Basin exist at a depth of 300 meters and this would cost 3 million Kenya shillings to drill a single borehole. The study also revealed that a project that would pump 9,000 m³/day of water from Turkwel dam to Lokichar oil field would cost 148 million Ksh. This study established from the technical director of the Oil company operating in Lokichar that oil production consumes a lot of water and therefore proper strategies need to be laid down before large scale oil production begins. Plans to recycle formation water especially once productions starts have to be put in place and adoption of technologies such as horizontal well drilling as explained by Joshi (2003) and discussed in section

4.3.1.3 needs to be carried out. These technologies will help in avoiding the over withdraw of water from the aquifers during oil production. The County Government needs to implement the Turkana County Integrated Development Plan 2013-2017 recommendations of helping the communities in building shallow wells, sub-surface dams and also undertake roof catchments to harvest rainwater for those with modern guttered roofing materials. Programmes aimed at harnessing water as recommended from Kerio and Turkwel Rivers and from deep aquifers will also be of great importance.

4.4.3 Oil and Gas Exploration Effects on Health Sector in Oil Block 13T South Lokichar Basin.

As part of their cooperate social responsibility, the Oil companies have invested immensely in the health sector of Oil Block 13T South Lokichar Basin. To supplement the work being done by the County Government, the Oil companies have constructed and equipped 3 sub-county level hospitals, refurbished 3 and constructed two dispensaries as per February 2018 as shown in Table 4.7 below. There is a total number of 20 health facilities in Turkana South Sub-County most of which were built in the last 3 years. 5 of these health facilities have been put up or refurbished by the Oil companies while the other 13 have been put up and refurbished by the County Government of Turkana in its effort to improve health services accessibility to the locals. Lokichar Sub-County hospital shown in Plate 4.18 was put up by Tullow BV. Kenya Ltd in 2015 and the hospital is offering comprehensive medical services and surgery and has a 32 bed capacity for the inpatient. Previously for a comprehensive medical service and surgery the patients from Turkana South Sub-County had to be referred to Lodwar County hospital a distance of 130 kilometres.

Nineteen of the health facilities within Turkana South-Sub County were dispensaries and 1 health centre and all of them except Locheremoit and Loperot dispensaries operate only during the day time on week days. Before 2013, the average distance that the locals especially those living in the villages had to walk to access a health facility, was 50 kilometres in Turkana County. The study established that this distance has reduced to 20 kilometres on average and this is in accordance to the Turkana County Integrated Development Plan 2013-2017. In addition the study noted that apart from Turkana South, Tullow BV.Kenya has also constructed two more Sub-County hospitals in Turkana East Sub-County, that is, Lokori and Kanamkerer hospital in Turkana Central Sub-County with similar bed capacities and offering both comprehensive and surgical services.

The study established that in areas where the Oil companies have supplemented the County Government in construction and equipping of health facilities such as in Turkana South-Sub County and part of Turkana East, the distance from the villages to the nearest health facility had reduced to between 10-20 kilometres, however this is still higher to the World Health Organisation's recommended distance of 5 kilometers. The study sought to know the views of the locals regarding the contribution of the oil and gas exploration ventures to the availability and improvement of health services in the study area. Their attitudes where (n=361) were presented in figure 4.18 below. 50% of the respondents felt that health facilities and services availability had adequately improved since the oil and gas exploration activities began against 22% who felt that the health services availability were adequate before the activities started.

Table 4.7: Health facilities projects constructed by the Oil companies in the study area

Project name	Project status
Lokichar sub-county hospital-Construction of a new level 3 hospital	The project already completed and handed over to the community and the County Government
Kasuroi health centre-Rehabilitation and refurbishment of an existing dispensary	The project already completed and handed over to the community and the County Government
Lowarengak health centre (Construction)	The project already completed and handed over to the County Government
Nakukulas dispensary(Construction)	The project already completed and handed over to the community and the County Government
Lokori Sub-county hospital(Construction)	The project already completed and handed over to the community and the County Government
Kanamkemer Sub-county hospital(Construction)	The project already and handed over to the community and the County Government
Napeitom Dispensary Rehabilitation and refurbishment of an existing dispensary	The project already completed and handed over to the community and the County Government
Loperot Dispensary Rehabilitation and refurbishment of an existing dispensary	The project already completed and handed over to the community and the County Government

(Data source: Tullow BV.Kenya Ltd. 2018)

10% of the respondents felt that with oil and gas exploration activities taking place in the study area, the health facilities and services availability were moderately available compared to 6% before the operations began. Although some people felt that the health services availability had adequately improved, 35% thought that the services were inadequate with oil and gas exploration compared to 20% before the oil and gas exploration began. 52% of the respondent said that the services were and facilities were poor before the oil and gas exploration activities began compared to the 12% who felt the same after the oil and gas exploration activities began. Sustainable health services in the study area can only be realised through a private-public partnership between the Oil companies and the County Government.

As part of corporate's social responsibilities, the Oil companies need to put up hospitals privately owned by the Oil companies, but open to the members of the public, where they can access medical services at subsidised prices. Several companies operating in remote areas have adopted this model. Kimanthi (2016) reveals a similar model with Mabati Rolling Mills Ltd., a local Kenyan company that opened up its staff clinic in 2002 to the members of the public living around the company at Mariakani in Kilifi County. The County Government needs to develop policies that would ensure that the constructed community health facilities are adopted and sustainably managed by the government. More health professionals need to be trained in the County to work in these facilities and the 159 facilities refurbished and constructed by the County Government. The current number of health professionals in the County as per August 2018 is 800 (RoK, 2018). The data is the total number of nurses, doctors, pharmaceutical technologist, laboratory technicians, clinical officers and health record workers. Doctor population ratio stands at 1:70,000 while nurse/population ratio is 1:5200 which is not adequate. The perfect minimum health worker to population ratio should be 23 health workers to 10,000 people or 40 clinical officers per 100,000 people, 32 doctors per 100,000 people or 95 nurses per 100,000 people (WHO 2017).

The Kenya average ratio of doctors to the population is 1:17000 meaning that the doctors population ratio in Turkana County is extremely low compared to the national ratio.

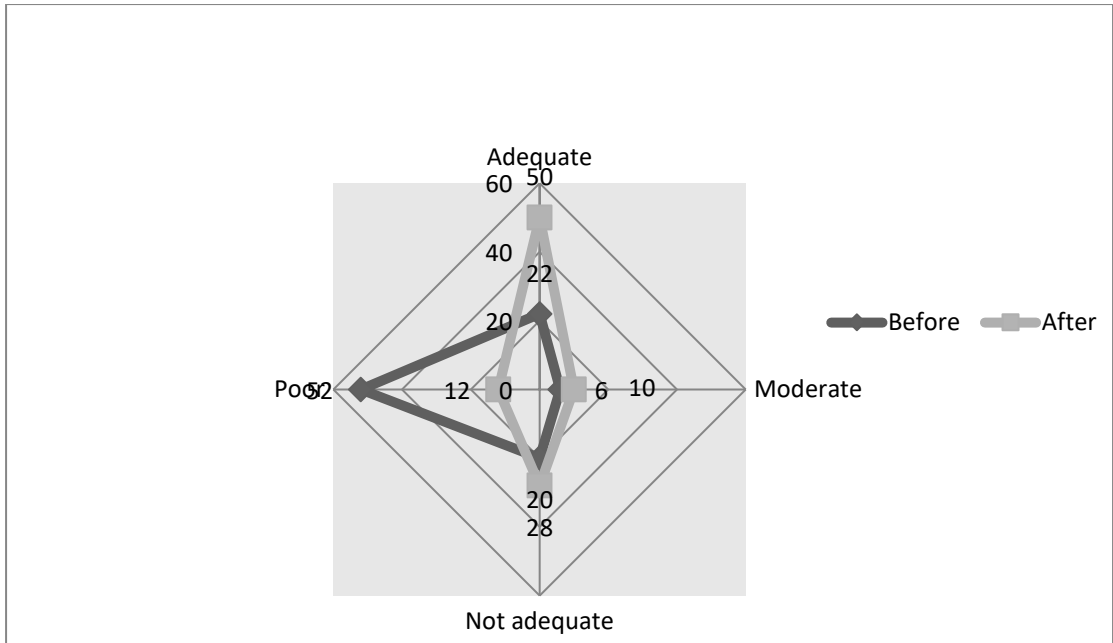


Figure 4.18:Locals’ opinions in percentages on establishment of health facilities and services pre and post commencement of oil and gas exploration (Data Source: Field survey, 2017)



Plate 4.18:Lokichar Sub-County hospital funded and constructed by Tullow BV Kenya Ltd. in the study area. (Photo: Researcher, July 2017)

The study also established that the patient's numbers were overwhelming the low number of the health workers operating within the health facilities in the study area. The local clinical officers from Lokichar RCEA Health Centre, Loperot dispensary and Kasuroi dispensary informed this study that since oil and gas exploration activities commenced in 2011, respiratory tract infections, eye infections and skin infections have been on the rise since. The clinical officers attributed the mentioned diseases to likely air and water pollution that they suggested may have originated from oil and gas exploration activities. The revelations from the health officials are consistent with Ajugwo (2013) and Ajasin *et al.* (2009) who noted that air pollution and water pollution from oil and gas exploration activities are hazards for respiratory, eye and skin infections.

However, this study cannot with finality conclude that the rise in the numbers of these health conditions in the study area was because of the oil and gas exploration emissions and water pollution. Nevertheless, the locals through the focused group discussions believe that oil and gas exploration activities has caused diseases to them. In addition, the photos of the gas being flared as shown in Plate 4.16, the levels of selected heavy metals and Turbidity of water samples as shown in table 4.6 indicate a likelihood of contribution of pollutants from the oil and gas exploration activities in the study area to the health challenges being observed in the area. This likelihood is supported further by health data of the mentioned conditions from the Ministry of Health DHIS database shown in Table 4.8 below and the etiologies and pathologies reports of the treated conditions given by the clinical officers in the study area.

Similar studies done by Ajugwo (2013) and Ajasin *et al.* (2009) attributed similar health challenges to oil and gas exploration in Niger Delta. This calls for proper management of the health facilities within the area of study to ensure adequate and timely

management of these cases to avoid the risks of losing human lives in the area. It is imperative to note that, the results of conditions depicted below have different etiologies such as air and water pollution from other sources and this study does not conclusively state that pollution from the oil and gas exploration activities in Oil Block 13T South Lokichar Basin is the only hazard. The study however observed a strong linear correlation between temporal changes and the number of indications noted by the health professionals and previous studies since the oil and gas exploration activities began in Oil Block 13T South Lokichar Basin.

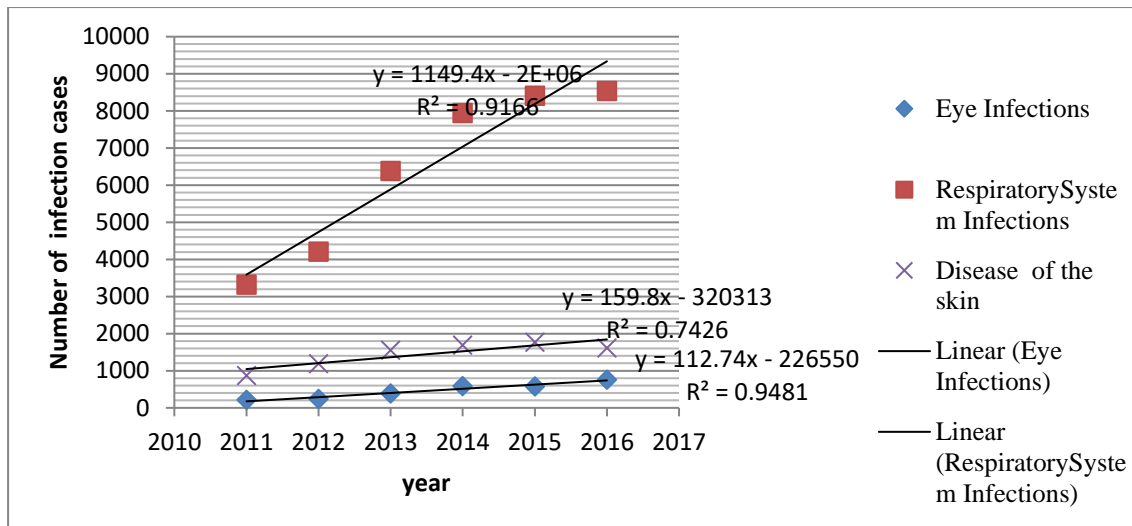
Period	Facility	Eye Infections	Respiratory Infections	Skin Infections
2016	Locheremoit Dispensary	146	2657	466
	Lokichar RCEA Health Centre	292	3863	986
	Loperot	317	2012	159
Totals		755	8532	1611
2015	Locheremoit Dispensary	128	2407	377
	Lokichar RCEA Health Centre	219	3852	1367
	Loperot Dispensary	228	2143	18
Totals		575	8402	1762
2014	Locheremoit Dispensary	124	2302	306
	Lokichar RCEA Health Center	163	3813	1276
	Loperot Dispensary	299	1820	107
Totals		586	7936	1689
2013	Locheremoit Dispensary	73	1093	217
	Lokichar RCEA Health Center	143	3568	1259
	Loperot Dispensary	165	1721	75
		381	6382	1551
2012	Locheremoit Dispensary	56	526	97
	Lokichar RCEA Health Centre	132	3081	1029
	Loperot Dispensary	50	600	61
Totals		238	4207	1187
2011	Lochemoit Dispensary	53	495	37
	Lokichar RCEA Health Centre	122	2398	775
	Loperot Dispensary	34	421	53
Totals		209	3314	865

Alvarez and Paraphos(2012) observed that exposure of humans to oil and gas exploration associated pollutants such as Nitrogen Oxides (NO_x), Volatile Organic Compounds (toluene, xylenes, aldehydes, ethylbenzene), Sulphur Oxides (SO_x) and heavy metals have been documented to be health hazards of the named health conditions among other etiologies. This argument is consistent with the study done by Okoro *etal* (2006) ,who records that inhalation, contacts or ingestion of hydrocarbon and heavy metals by humans may result to health conditions such as respiratory tract, skin and eye infections. Clinical officers from Lokichar Integrated Health Facility, Loperot and Locheremoit dispensaries revealed that the mentioned maladies had intensified since the commencement of the oil and gas exploration activities in the area. Figure 4.19 shows a trend of respiratory tract, eye, and skin infections since 2011 as recorded in the health facilities in the study area. The study observed that if the assumption by the local clinical officers and the local communities is true that oil and gas exploration has caused air and water pollution there is a likelihood of local communities' exposure to the pollutants. This is because Oil Block 13T South Lokichar Basin is besieged by a number of hills which may lead to confinement of air pollutants in the area.

The hills that surround the basin are; Lokichar Hills, Loima, Kasoroi, Lomokumar and Natudao as noted in section 3.2.1 and these may hinder free flow of wind hence it may harbour the pollutant within the area and even create a micro-climate. The high levels of selected heavy metals in the community water boreholes as noted in Table 4.5 may also have contributed to the high number of these health cases consistent with Ajasin *etal*.(2009).

4.4.3.1 Temporal Pearson Linear Correlation of the Average Number of Respiratory, Eye and Skin Infections in the Study Area

Figure 4.19: Temporal Pearson linear correlation of average number of respiratory, skin, and eyes morbidity cases in the study area. (Data source: RoK, 2017)



From figure 4.19 above, all the three disease conditions displayed had a very strong positive linear correlation. The R-value for respiratory infections was 0.957 indicating a very strong linear correlation relationship across the years. The linear correlation R-value for eye infections was 0.861 and for skin infections was 0.973. All conditions as noted had a positive linear correlation and each of the situations across the years had a strong positive linear correlation relationship. A comparative analysis with data of similar disease conditions from other Sub-counties of Turkana County where little or no exploration had taken place, presented an opposite picture as shown in Table 4.9 below. The data from Turkana East Kapendo Sub-County hospital where little oil and gas exploration had been carried, data from Turkana West Sub-County Lokichogio AIC Outpatient hospital and data from Turkana Central Sub-County Ngiitakio Dispensary were all examined. By 2017, much of the oil and gas exploration activities in Oil Block 13T South Lokichar Basin had been carried out in Turkana South Sub-County with

little exploration in Turkana East and Central Sub-counties. Oil and gas exploration was yet to commence in Turkana West Sub-County. The trend of the cases in the latter two Sub-counties did indicate a weak linear correlation when compared to the pattern of the same in Turkana South Sub-county.

Table 4.9: Average numbers of morbidity cases in the health facilities found in Turkana East, West & Central Sub-counties (Source:RoK, 2017)

Year	Health facilities in other Sub-Counties	Eye infections	Resp.tract infections	Skin infections
2012	Kapendo hospital, Turkana East	11	199	109
	Ngiitakio dispensary Turkana central	8	118	6
	Lokichogio AIC outpatient Turkana West	201	448	120
2013	Kapendo hospital Turkana East	217	2580	650
	Ngiitakio dispensary Turkana Central	6	1079	140
	Lokichogio AIC outpatient Turkana West	121	406	135
2014	Kapendo hospital Turkana East	79	1653	232
	Ngiitakio dispensary Turkana Central	5	1778	
	Lokichogio AIC outpatient Turkana West	79	390	132
2015	Kapendo Sub-County hospital Turkana East	88	1800	268
	Ngiitakio Dispensary Turkana Central	17	1790	227
	Lokichogio AIC outpatient Turkana West	97	327	193
2016	Kapendo hospital Turkana East	92	1240	296
	Ngiitakio Dispensary Turkana Central	21	1847	88
	Lokichogio AIC outpatient West	576	334	193

The study established that data from Turkana West Sub-County where oil and gas exploration had not taken place at all depicted low numbers for the eye infections in 2016. The average morbidity cases were on average rising in Kapendo Sub-County hospital in Turkana East per annum and in Ngiitakio dispensary in Turkana Central Sub-County but the numbers were not as high as those in Turkana South Sub-County.

In Turkana West, the disease cases were on average either constant or declining across the five years period. A scatter plot to show the linear correlation of the morbidities with time in these areas is shown in figure 4.20 below.

4.4.3.2 Temporal Pearson Linear Correlation for the Average Number of Diseases in Sub-Counties outside the Study Area

From figure 4.20 below, though the Pearson correlation is linear meaning that generally, the indications were on the rise, the R-value for respiratory infections was 0.789, which was a weaker linear correlation, compared to 0.954 of the study area. The R-value for the Pearson linear correlation for the eye infections was 0.487, and that of skin infections was 0.435, which both indicated a weaker Pearson linear correlation when compared to 0.861 and 0.974 respectively for the health facilities found in the study area as shown in section 4.4.3.1

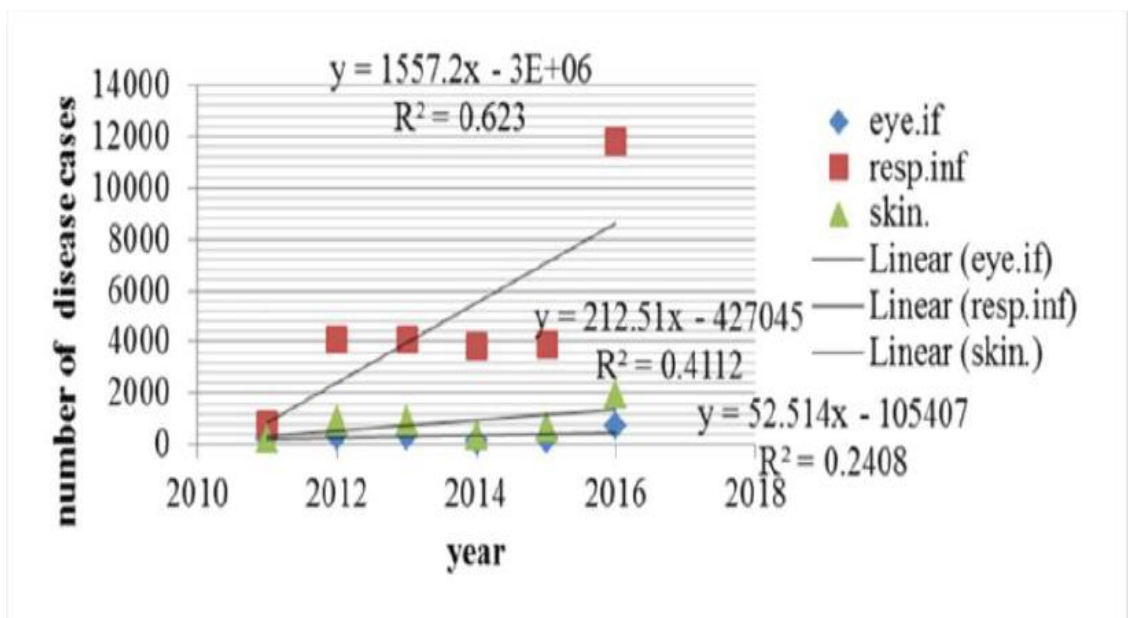


Figure 4.20: Temporal Pearson linear correlation of average number of respiratory tract, eye and skin infections in health facilities found in Turkana Central, Turkana West and Turkana East Sub-counties. (Data source: RoK, 2017)

The study examined the trend of the same disorders in Baragoi Sub-County hospital from the neighbouring Samburu County. Figure 4.21 below shows that the numbers of morbidity cases were decreasing or they were constant as time changed. The study observed that where there was an increase, it was with a minimal margin. The fact that there are no oil and gas exploration activities in Samburu North Sub-County indicates that the conventional etiologies of the respiratory tract, eye and skin infections were responsible for the trend of these diseases. These observations together with those made in other Sub-Counties like Turkana West Sub-County are pointers to a likelihood of air and water pollutants from oil and gas exploration activities which may have resulted to infections.

4.4.3.2 Temporal Pearson Linear Correlation of Average Number of Respiratory tract, eye and skin infections in the Neighbouring Samburu County.

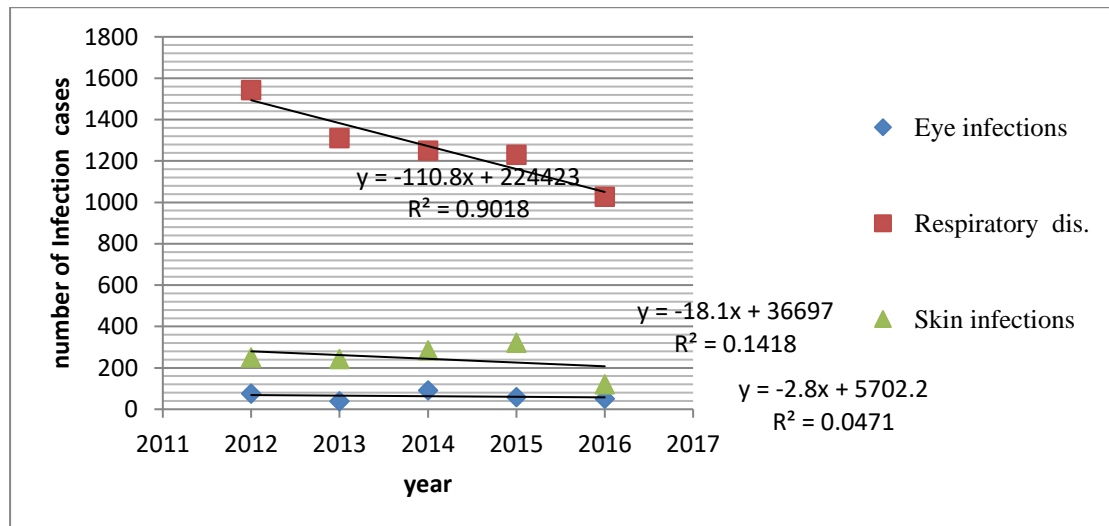


Figure 4.21: Temporal Pearson linear correlation of average number of respiratory tract, eye and skin infections in health facilities found in Baragoi sub county ,Samburu County.(Data source:RoK, 2017)

The value for Pearson (R) Linear Correlation for the respiratory tract infections across the years was -0.949, which was a very strong negative linear correlation indicating that

the cases were declining with every subsequent year. The one for skin infections was -0.376, while that of eye infections was -0.217 and both of them represented a negative linear correlation. The findings were different from the one for Lokichar health facilities and other facilities within Turkana County as earlier noted suggesting a likelihood of exploration activities to have had an effect to the quality of air and water in the study area.

From the above analysis, health facilities adjacent to the active oil and gas exploration sites recorded the highest number of respiratory tract, eye and skin infections. The study observed that these cases were exponentially rising especially in Turkana South Sub-County. Areas without active oil and gas exploration like Turkana West Sub-County and Baragoi in Samburu County depicted an inverse temporal linear correlation of morbidities across the years. These findings concur with the study done by Ramon Arvarez and Elizabeth (2012), in Niger Delta. Their study noted that exposure to pollutants from oil and gas exploration activities through ingestion, contacts or inhalation can cause or exacerbate conditions such as respiratory tract infections, eye infections, and skin infections. In addition, they indicate that the exposure is always more severe in the areas nearest to the oil and gas exploration sites. This study, therefore, observes that there is a likelihood of air and water pollution around the study area that may be attributed to the rising number of these morbidity cases in Oil Block 13T South Lokichar Basin.

The study established that Tullow BV. Kenya Ltd. was intending to drill 300 oil wells by 2023 in Oil Block 13T South Lokichar Basin. There is a need therefore for in-depth research on the impact of the oil and gas exploration on people's health in South Lokichar Basin. The fact that the Oil companies and the County Government have built health facilities in the study area should be followed by massive recruitment of health

workers to manage the rising or the potential health challenges that come with pollution from oil and gas exploration and production. The County Government of Turkana must develop a universal health care policy to help the locals access free medical care for early diagnosis and treatment of any health challenge that may arise from oil and gas exploration activities. The County Government should also equip all the community health facilities constructed by the Oil companies and stock them with medicine since health is a devolved sector.

4.4.4 Oil and Gas Exploration Effects on Education Sector in the Study Area

There are 32 secondary schools and 315 primary schools in the entire County of Turkana. Kakuma Women Home Crafts and Lodwar Youth Polytechnic are the only two polytechnic in the region. The County has two colleges, that is the ECD Teachers Training College and the Kenya Medical Training College. In addition there are only two University Campus that is Turkana University College (A constituent college of Masinde Muliro University) in Lodwar and University of Nairobi Campus in Lokichoggio Town. A Technical Training Institute is being constructed in Lodwar through the Economic Stimulus Programme (ESP) by the Ministry of Higher Education. (CGT, 2017). The study sought to understand the views of the locals on the effects of oil and gas exploration on the education sector before and after the oil and gas exploration activities began. The study interviewed the key informants such as the headteacher of Lokichar Mixed Secondary School, the head teacher of Uhuru High School and a primary school teacher from Namskoni Primary School. The study also interviewed the Turkana County Deputy Director of Education, the Lokichar Location Chief and a programme coordinator of Friends of Lake Turkana, a local NGO and the Director of communications of the main oil and gas exploration company in Oil Block

13T South Lokichar Basin. An interview with County Deputy Director of Education revealed that the nomadic lifestyle of the local communities, frequent droughts, lack of awareness of the value of education among parents, high illiteracy levels among adults, and chronic poverty are major drawbacks to children's education in the county. Only 50% of primary school-aged children in Turkana County are registered in school which is less than the 92% Kenya national children school enrolment average.

The adult literacy level in the county stands at 20 %.The study learnt that lack of facilities such as enough dormitories,science laboratories,desks, books, schools' perimeter fences and food were the major challenges that were engulfing the education sector in the area.However the study learnt that through the Rapid School Readiness Initiative programme initiated by the Government of Kenya, the UNICEF and an initiative of the County Government dubbed Turkana Education for All the challenges of lack of awareness and accessibility to education centres is being dealt with.The Ministry of Education through this programme is sending education officers to sensitise communities about the significance of education for their children.The initiative has also seen the growth of six ECDE Makeshift Centre into schools in Turkana South and Turkana East Sub-Counties.

A mobile education facility for nomadic children has also been formally introduced and approved by the Kenyan Government and this has really improved the education sector in the area.The study did a household survey (where n=361) to establish the views of the locals on matters of education facilities and services in the study area in the advent of oil and gas exploration. Figure 4.22 shows the attitudes in percentages of the locals. 30% of the respondents believed that education facilities and services had adequately improved since oil and gas exploration activities began compared to 18% who felt that the facilities and services were adequate before the oil and gas exploration activities

began 40% believed that the education facilities and services availability around the study area were moderate since oil and gas exploration began compared to 22% who had the same feeling for the levels of education facilities and services in the area before the oil and gas exploration activities started. 28% of the interviewee believed that the education facilities and services had not adequately improved since the oil and gas exploration started compared to 38% who felt the same before the oil and gas exploration began. 2% of all the interviewees said that the education facilities and services were poor since the oil and gas exploration activities started compared to 24% who felt that the services were poor before the oil and gas exploration activities began. In general, the locals felt that since oil and gas exploration activities began, there were progressive, positive changes starting with moderate to adequate.

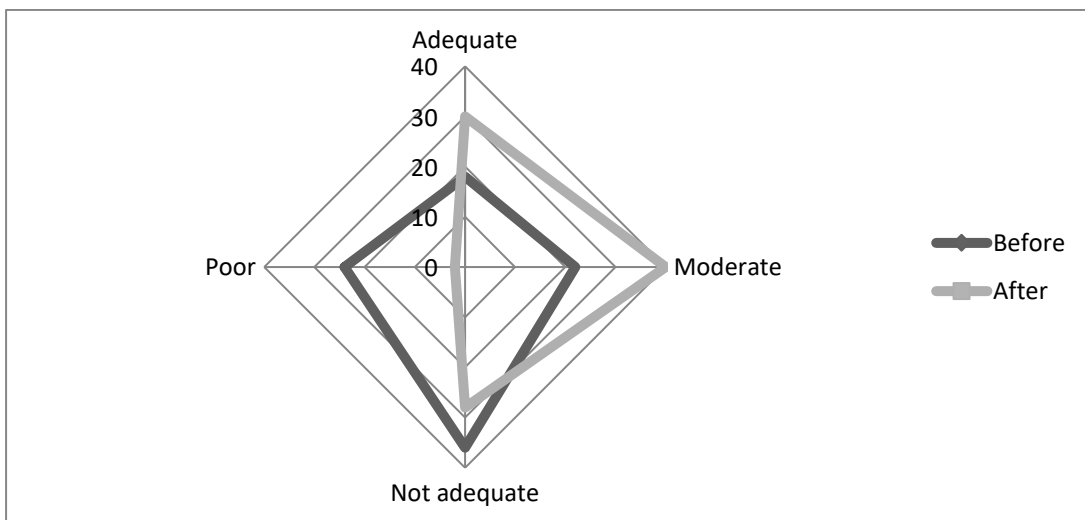


Figure 4.22: Locals' opinions in percentages over establishment of educational facilities and services before and after oil and gas exploration activities began in Oil Block 13T South Lokichar Basin (Data source: Field survey, 2017)

The study tried to interrogate the reactions and several factors may have contributed to a significant percentage of the respondents believing that the oil and gas exploration had impacted positively to education facilities and services in the area. An interview with an Oil company official and ground truthing observations revealed that by July

2018, the Oil companies had invested in 17 education projects within Oil Block 13T South Lokichar Basin as shown in Table 4.10 below as part of their CSR which were not there before the oil and gas exploration begun

Table 4.10: Education projects funded by the Oil companies in the Study area(Data source: Field survey, 2017)

Project name	Status of the project
Kainuk secondary school-construction of a dormitory for 60 students	The project already completed and handed over to the school community
Katilu girls secondary school construction of a science laboratory	The project already completed and handed over to the school community
Uhuru high school-Construction of 1 dormitory for 60 students	The project already completed and handed over to the school community
Morulem secondary school -construction of a science laboratory	The project already completed and handed over to the school community
Lomokamar primary –construction of two classrooms and 40 desks	The project already completed and handed over to the school community
Lochwaa, Kaaruko, Lokichada Lopii, Lokwamosing primary schools -Fences	The projects already completed and handed over to the school community In progress
Milima Tatu Secondary school-construction of 3 classrooms	The project already completed and handed over to the school community
Nachukui secondary school dormitory construction 60 bed capacity	The project already completed and handed over to the school community
Lopii primary school -construction of 2 classrooms and a 400x 400 fence	The project already completed and handed over to the school community
Kekorisogol primary school- construction of a classroom and desks	The project already completed and handed over to the school community
Nakukulus boys and girls -construction of 60 capacity dormitories and beds	The project already completed and handed over to the school community
Karuko primary school- construction of 2 classrooms	The project already completed and handed over to the school community
Kekorisogoi Primary School-construction a dormitory and supply of 50 double deck beds	The project already completed and handed over to the school community
Karoge primary schools - classrooms with a capacity of 60 students	The project already completed and handed over to the school community
Lochoredome, primary schools - classrooms with a capacity of 60 students	The project already completed and handed over to the school community
Ngimuriae primary schools - classrooms with a capacity of 60 students	The project already completed and handed over to the school community
Scholarships for 25 secondary school students	On-going project
Scholarship to 55 students for their postgraduates in UK universities in 2014	Already graduated and 10 of them working with the Oil companies

Plate 4.19 shows one of the dormitories that was funded and constructed by the Oil company at Uhuru high school in the study area. Although there is a lot of transformation being brought by the Oil companies, regarding infrastructures in the existing schools, this study in an interview with the headteachers established that once the projects get completed, they usually get handed over to the specific schools for the management and others to the community.



Plate 4.19: A 60 bed capacity dormitory financed by the Oil companies at Uhuru high school (Photo: Researcher, July 2017)

The study observed that, the local parents had challenges in paying for their children's school fees, the community schools built by the Oil companies need to be adopted and managed by a local religious organisation or NGO for its sustainability. The study also established that despite the many strides that had been made in the education sector in the study area, oil and gas exploration activities had brought a share of its challenges to the sector as well. The study learnt that the demand for semi-skilled labour in the Oil companies and the enticing remunerations had led to dropping out of school of some high school going students between 2013 and 2016 an issue pointed out to be a

challenge in the focused group discussions. The study also noted from the school heads that the high number of men who were working in the Oil companies were luring the young girls with money and there were increasing number of unwanted pregnancies with one of the teachers indicating that three of his former students had fallen victims of the early pregnancies. The study through an interview with the local youth leaders observed that the local youth who had benefitted from the postgraduates oversee scholarships offered by the Oil companies in 2014 had already completed their studies and they were yet to be employed in the Oil companies.

Sustainable management of education sector in the backdrop of oil and gas exploration in Oil Block 13T South Lokichar Basin will be realised if, Oil companies sets a minimum academic qualification for semi-skilled labour force and the minimum academic requirement for those below 21 years of age to be a high school certificate. This will encourage the culture of sticking to school for the young people especially as commercial oil production begins. The schools in Oil Block 13T South Lokichar Basin needs to intensify on their counselling programs and education on HIV/AIDS and other sexually transmitted diseases.

From Table 4.12, it is clear that the prevalence rate for new HIV cases for the school-going children between the ages of 15-24 years has been on the rise since 2013. Other supports that the County Government and other partners needs to offer to ensure sustainable education sector in the area entails training of teachers and school committees, paying mobile school teachers who are not yet on the Government payroll and providing books and other resources to ensure quality of the education. The Oil companies too and the local leaders can identify sponsors such as religious organisations to help in managing the community schools that they have helped to build.

4.4.5 Oil and Gas Exploration Effects on Locals Income and Livelihoods

An interview with the Director of communications from the Main oil exploring company revealed that the Oil companies as part of their CSR had engaged in projects meant to transform the livelihoods of the young people around the study area. One of the projects situated in the Oil company offices at Lokichar town is a Livelihood and Enterprise Development Centre where the local young people are being trained in skills such as computer applications and entrepreneurship. However, the only challenge according to the locals is that even non-locals are competing for the limited space that offers the training, the Oil company does not have a proper criterion for filtering the locals from non-locals and hence the locals fail to benefit. Job creation has been a significant contribution of the Oil companies in the study area.

The study established through an interview with the Oil Company Cooperate Affairs Department that when oil and gas exploration activities began in 2012 in Turkana, 1500 people were employed by the Oil companies directly and through contracted service companies to offer skilled and semi-skilled services. The study established that the semi-skilled casual workers are earning a total monthly salary of between 30,000-40,000 Ksh and 80,000-100,000 Ksh. for the semi-skilled workers on 3 months renewable contracts, though when the work is low their contract may fail to be renewed hence their jobs are seasonal. The skilled permanent workers were earning between 100,000-300,000 Ksh. per month and were employed on a 2 years renewable contract. The study also learnt that 80% of the semi-skilled workers were herds men or jobless before they secured employments with the Oil companies. 80% of the few skilled workforce from the local area were previously working with the local NGOs which were remunerating them between 70,000-100,000 Ksh. The study also learnt through the Director of Communications of the main Oil company operating in Oil

Block 13T South Lokichar Basin that by December 2014 the Oil companies operating in Oil Block 13T South Lokichar Basin directly and through contractors and subcontractors had employed 174 expatriate representing 6% of members of staff, 791 national non-locals representing 29% of the staff members and 1,776 locals representing 65% of staff members as shown in figure 4.23 below. However these numbers reduced when the Oil companies retrenched towards the end of year 2015 and early 2016 and by July 2018 there were 35 expatriates representing 5% of the total employees 282 non locals from other counties representing 38% of the employees and 419 locals representing 57% of all the employees working with the oil exploring companies in Oil Block 13T South Lokichar Basin.

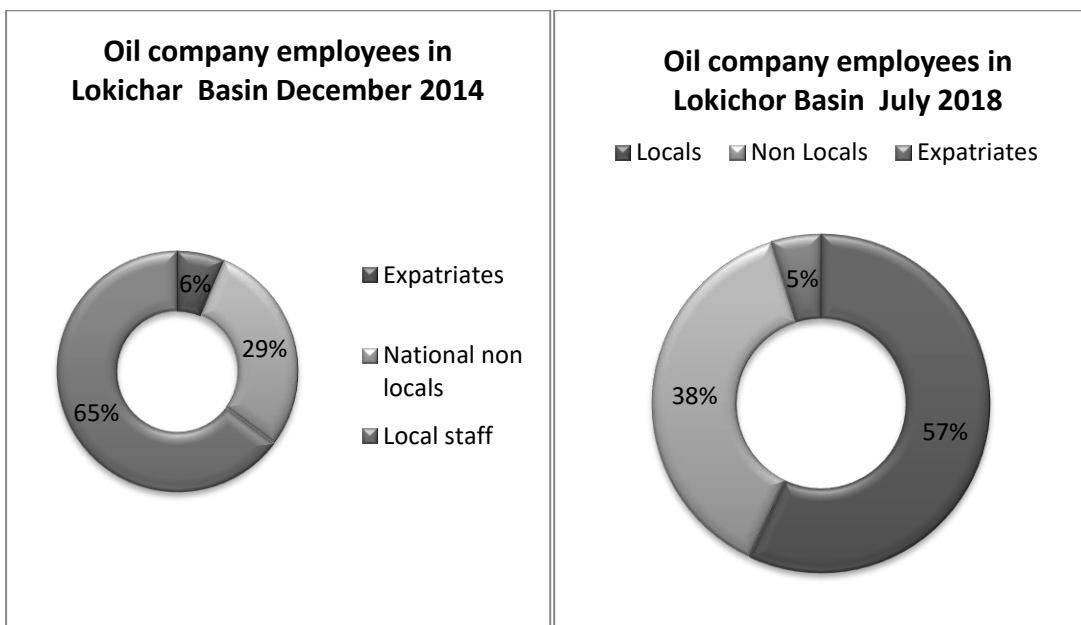


Figure 4.23: Categories in percentages of employees in the leading Oil Company operating in Oil Block 13T South Lokichar Basin in 2014 & 2018. (Data source: Tullow oil BV Kenya, 2017)

The study learnt that the Oil companies have been contracting and subcontracting different companies to offer various services, starting from waste collection transportation and management, printing and stationery services, transport services for exploration chemicals and water, maintenance and repair services for their machinery,

access roads construction services, catering services among others. The contracted companies by August 2018 were; Amailo Investment Company Ltd., Baker Hughes, Control Risks EA Ltd., Dover(K)Ltd, ECCL Ltd, FFK, Geolog International Kenya, Halliburton, IDEC, Qmax, Jagab Contractors, Kapese Transporters Ltd., KK Security, Logistics Team International, Afex Group, All Terrain Services (K) Ltd. Most of these companies are owned by the locals and them that are not owned by locals are expected to give priority to the locals on employment.

The study established that the primary challenge has been lack of skilled labour from the local area, and therefore, the companies have been forced to employ the national non locals constituting 38% and expatriate who constitutes 5% of the total company employees. The percentage of the local employees in the company however has gone down by 8% as shown in figure 4.23 and that of the national non-locals has gone up by 9% from 2014 to 2018. This trend of employing national non-locals is expected to continue as the demand for more skilled employees increases as full scale oil production begins. This scenario has triggered employment related conflicts as discussed in depth in section 4.4.15. The findings demonstrate the danger the locals may find themselves in regard to their livelihoods if capacity building and investment in other economic sources is not adequately done.

A survey (where n=361) was carried out on the locals who live in the 'Manyattas' and the peri-urban area of Lokichar town centre to get their views on the effects of the oil and gas exploration activities to their livelihoods, mainly focusing on their source of incomes. The findings of this study concurred with the outcomes of research done by Nyanchoga and Alfayo (2014) who noted that the primary source of livelihoods in Turkana County is pastoralism. The study established that pre commencement of oil and gas exploration, 62% of the locals in Oil Block 13T South Lokichar Basin depended on

pastoralism as the main source of livelihood, 17% depended on trade while 14% depended on trade. Aid from the government and small scale farming formed 0.7 and 5% as the main source of income for the locals respectively. These percentages changed to 51%, 20%, 20%, 0.7 and 5% respectively since the oil and gas exploration activities commenced. The percentage of those earning their source of income from rental housing increased from 1% before oil and gas exploration activities to 3% after the commencement of oil and gas exploration. The study established that the increased percentage of the people earning salary and wages were working with the Oil companies in Oil Block 13T South Lokichar Basin. Increased number of traders was due to the growth and expansion of Lokichar town and connection of the area to the national grid electricity.

The interviewees had invested in small business within the town, and the influx of new people offered ready markets for their pastoral products such as meat and milk. Small-scale farming which mostly gets practised along river Turkwel and river Kerio and through irrigation came fourth with 5%. A few people who mostly comprised of the elderly above 70 years old said that they mainly depended on NGOs and Government aid as their source of income. This group represented 0.7% of the total respondents from the study area and these were not affected by the oil and gas exploration activities. The results are shown in figure 4.24 below.

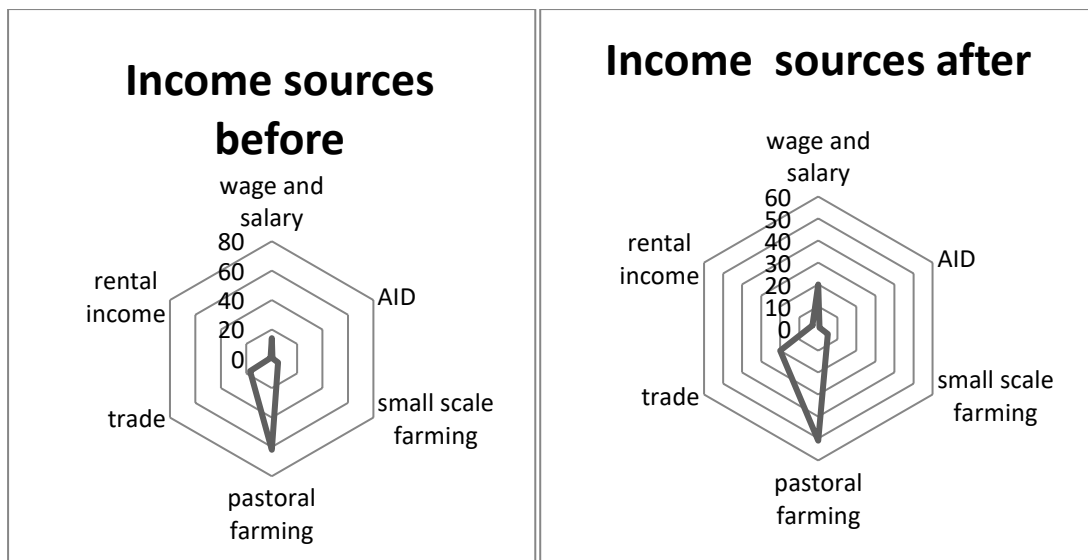


Figure 4.24: Main income sources of the locals in percentages pre and post oil and gas exploration (Data source: Field survey, 2017)

The study assessed the amounts of income the locals were earning before and after the oil and gas exploration activities began in Lokichar and the findings were shown in the frequency Table 4.11 below. From the analysis before the oil and gas exploration activities began, 53.5% of the locals were earning between 1000-10000 Ksh. per month and the study noted that they were mostly pastoralists. This number was higher compared to 34% of the locals who were earning the same amount after the oil and gas exploration activities began in Oil Block 13T South Lokichar Basin. The study noted that a bigger percentage of the locals had secured casual jobs with the Oil companies. The category of the people earning between 11,000-20000 Ksh. improved from 26.4% before oil and gas exploration commenced to 31.3% after the exploration activities commenced. The study noted that this had been contributed mostly by increased small trade especially within the urban areas of Lokichar. Those earning between 21000-30000 Ksh., the numbers increased from 9.5% to 28.5%. The study noted that most of these people were working with the Oil companies and others were business communities within Lokichar town. The category of the people earning above 30000 Ksh. increased from

4.4% to 6.3%. However those that were earning their source of livelihood from pastoral activities lamented that their income sources had been adversely affected by the oil and gas exploration activities and as noted in figure 4.24, pastoralism was the main source of livelihood.

Table 4.11: Amount of the Income of the locals before and after the commencement of oil and gas exploration in Oil Block 13T South Lokichar Basin

Net monthly income before oil exploration began in Ksh.					
Income category		Frequency	Percent	Valid Percent	Cumulative Percent
	1000-10000	172	59.7	59.7	59.7
	11000-20000	76	26.4	26.4	86.1
	21000-30000	30	10.4	10.4	96.5
	above 30000	10	3.5	3.5	100.0
	Total	288	100.0	100.0	
Net monthly income after oil and gas exploration begun in Ksh.					
Income category		Frequency	Percent	Valid Percent	Cumulative Percent
	1000-10000	98	34.0	34.0	34.0
	11000-20000	90	31.3	31.3	65.3
	21000-30000	70	24.3	24.3	89.6
	above 30000	30	10.4	10.4	100.0
	Total	288	100.0	100.0	

The study established that except for the locals who were still depending on pastoral activities for their livelihoods and not involved in any form of trade, the income of the traders and the business communities, employees who had secured job opportunities in the Oil companies and the small scale farmers had improved. This is consistent with Plänitz & Kuzu (2015) who noted that oil and gas exploration activities come with a bit of seasonal transformation on people's income since there is a flow of liquid cash.

4.4.5.1 Chi-Square Test of the Hypothesis on the Significant Difference on the Locals Income Before and After Commencement of Oil and gas exploration.

A Chi-square analysis shown in Table 4.12 below did indicate a significant difference on the amount of income earned by the locals pre and post oil and gas exploration activities began in Oil Block 13T South Lokichar Basin.

Table 4.12: Chi-square Test for Locals Income Pre and Post Oil and Gas Exploration Commencement

	monthly income after exploration				Total
	1000-10000	11000-20000	21000-30000	above 30000	
1000-10000	40	84	46	2	172
11000-20000	22	2	36	16	76
21000-30000	8	2	0	0	30
above 30000	28	2	0	0	10
Total	98	90	82	18	288

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	169.307 ^a	12	.000
Likelihood Ratio	180.801	12	.000
Linear-by-Linear Association	13.374	1	.000
N of Valid Cases	288		

The calculated Chi-square at 95% confidence interval, with a df of 12 at a significance level of 0.05 was 169.307. The 2-tailed significance level was $p=0.000 < \text{significance level } p=0.05$ hence the H_0 ; that there is no significant difference on the amount of income received by the locals before and after the commencement of oil and gas exploration was rejected and the study failed to reject the H_1 that there is a significant difference on the amount of income received by the locals before and after the commencement of oil and gas exploration. The study established that the local communities have many expectations on securing employment with the Oil companies, especially once oil production begins. This was evidenced by the fact that the percentage of the locals earning between 1000-10000 had reduced from 59.7% to 34% and most of these locals had secured employment in the Oil companies as shown in figure 4.8.

However, the study established through some locals who had worked for the Main oil exploring company that close to 1000 workers were affected when the companies failed to renew their contracts in late 2015 and early 2016. This was due to the global plunge in oil prices that plummeted to a cost below 50 \$ per barrel following four years of relative stability at around \$105 per barrel (bbl) until the end of 2016 (John *et al.*, 2016). The study learnt that these locals are still waiting to be recalled back as evidenced in figure 4.23. The findings of this study prove lack of sustainability of employment in oil industries in the study area. An interview with an Oil company official who sought anonymity confirmed the findings of Evans *et al.* (2016), that oil and gas exploration jobs are cyclical. The official revealed that in areas where the Oil companies were actively carrying out exploration activities, they always engaged high numbers of labourers across the categories, and when the number of activities goes

down, then they are always forced to retrench. The official further revealed that employment declines once a seismic survey has been completed but then resumes when drilling activities begin, and therefore this ends up causing phases of recruitment followed by retrenchment after a few months of action. Another factor disclosed to this study in an interview with the Oil company Cooperate affairs manager was the fact that global fluctuation of oil and gas prices has always led to global jobs downturn directly and indirectly.

The study validated the retrenchment assertion of the locals through an interview with the Oil company Director of Communications in Lokichar offices. He stated that in late 2015 and early 2016, the Oil companies operating in Oil Block 13T South Lokichar Basin, directly and indirectly, retrenched over 1000 employees due to drop of crude oil prices in the global market. The study also established that all the oil-exploring companies, operating in Kenya and many other countries globally, enter into a Production Sharing Agreement (PSA) with the government when being licensed to carry out exploration in various oil blocks. Under the PSA model, companies spend their money in exploration activities and would regain it once production begins. Plumation of oil prices in the global market immensely affects the liquid cash that they usually use to pay the various contractors and subcontractors and their employees. They are forced to downsize their members of staff and stop some contract for service provision as they cut down on their expenses. The scenario indicates that the locals need to capitalise on diversifying their sources of income and the County Government needs to develop trade policies that would enable value addition on the traditional sources of income such as pastoralism by investing in milk and meat processing plants, develop cottage industries such as weaving and basketry, invest in affordable water bottling plants from Eliye Springs in Lotikipii and reviving the fish processing plants. These

ventures would cushion the locals from over dependence on finite oil resources and the cyclic jobs associated with the resource.

In addition there is a need for the County Government, the Civil Society and the Oil companies to train the locals on entrepreneurial skills that can sustain them in the long terms. This observation is substantiated by a study done and published by IFAD (2012) over a similar situation in Kordofan State in Southern Sudan that recommended for diversification of the locals to other sources of livelihoods rather than depending on oil resources. Kadafa and Ayuba (2012) also note that incomes from the oil industry for the local communities are not sustainable as depicted by the communities living around the Niger Delta in Nigeria. The studies indicate that the communities traded their traditional economic activities for employment in the oil industries and most of them are currently living in abject poverty. A focused group discussion with the local elders in the study area revealed that the seismic surveys carried out in the area had led to reduced milk production among the communities living in Turkana South Sub-County due to the shocks and tremors that came with the technology. The situation may get worse once the oil production begins since the locals may eventually abandon their traditional sources of livelihoods resulting in a condition referred to as the 'Dutch Diseases Syndrome'. This term was formulated in the 1970 in Netherlands after the discovery of natural gas, which occasioned a go-slow in the economic development process in the country.

Information from the Ministry of Petroleum and Mining revealed that oil reserves in Kenya will have a substantial monetary impact to the economy with projected production estimated to peak at about \$8.9 billion in 2033. From land displacement to extensive exploration activities, to the local young people enrolling for training in the petroleum sector already happening in Lokichar, the Dutch diseases may affect Oil

Block 13T South Lokichar Basin and Turkana County in general as oil production commences.

Analysis on these ‘Dutch Diseases Syndrome’ indicates that there is more negative impact on the way, not only to the local communities in Oil Block 13T South Lokichar Basin but Kenyan Government as a whole especially on the forex earnings for the country as it embarks on commercial production of oil. This is because the sale of oil may cause an appreciation in value of the Kenyan shilling to the dollar, making exports of tourism and other agricultural products costly. These economic dynamics may eventually lead to the collapse of other industries, and as experienced in late 2015 and early 2016 when Oil companies retrenched, this too may lead to national massive job losses. There is, therefore, a great need for the continuous development of farming practices especially agribusiness, trade and value addition to pastoral farming in Turkana County to ensure sustainable sources of livelihood explicated in sustainable livelihood theory in section 2.5.3.

4.4.6 Oil and Gas Exploration and National Grid Electricity Connectivity in Oil Block 13T South Lokichar Basin.

The study established that the Government of Kenya commissioned a 1.69 billion Lokichar substation electricity project shown in Plate 4.20 below in 2017. The project connects the expansive arid Turkana County to the national grid, enhancing the residents’ access to reliable and reasonably priced electricity energy for the first time in history. The project got implemented through the Rural Electrification Authority to facilitate the exploration and production of oil resource in Oil Block 13T South Lokichar Basin. The Sub-station electricity project will serve Lokichar and Kalemung’orok towns and the peri-urban areas around these towns, but an interview

with a Kenya Power and Lightening Company official in the area revealed that plans were underway to extend it to Lodwar and other towns in the County, which depends on diesel generators as the main source of electric energy.



Plate 4.20: The Lokichar substation electricity project

As a result of this connection of the area to the national grid, the business sector has been boosted in the area and has attracted many investors. An interview with the KPLC Manager in Lokichar Substation established that In total by July 2018, 180 businesses within Lokichar town and 220 households in Kamarese Akanapus, Naoyatira, Narengellup, Nacholla, Lokoridoyo, Tinyouta, Nalemskoni and Kapese villages had been connected to the national grid electricity. The study observed that there were 400 KPLC metered domestic and commercial customers in Lokichar by August 2018. However, despite the connection of the area to the national grid, only urbanites and the peri-urbanites populations will benefit and many pastoralists living in the villages in the far flung areas of the county may not benefit from the development. This calls for a supplementary investment in a more sustainable energy sources such as the solar energy by the County Government. 65% of the locals in the

peri-urban zones and villages earn between 1000-20000 Ksh. as shown in Table 4.11 and this may pose a great challenge in affording monthly electricity bills. There is therefore a need by the County Government in addition to investing in solar energy to help the locals to diversify to different sources of income as discussed in details section 4.4.5 to help them sustain the payment of the electricity bills every month.

4.4.7 Oil and Gas Exploration and its Effects on Urban Growth and Population

Influx in Lokichar Town

Figure 4.25 shows a comparison of the building density infrastructures of Lokichar town before the oil and gas exploration activities began in 2010 and its status by the end of 2016. Several investors key among them Toyota Kenya have invested in the area including 3-star hotels known as the Black Gold. New guest houses have been put up and the existing ones including Lokichar, Patel, Rima, Another Chance, and Zebra guest houses have been upgraded to accommodate the ever-increasing size of the guests population in the area since 2012. Several business and residential houses have been built since 2012 as shown in figure 4.25 below

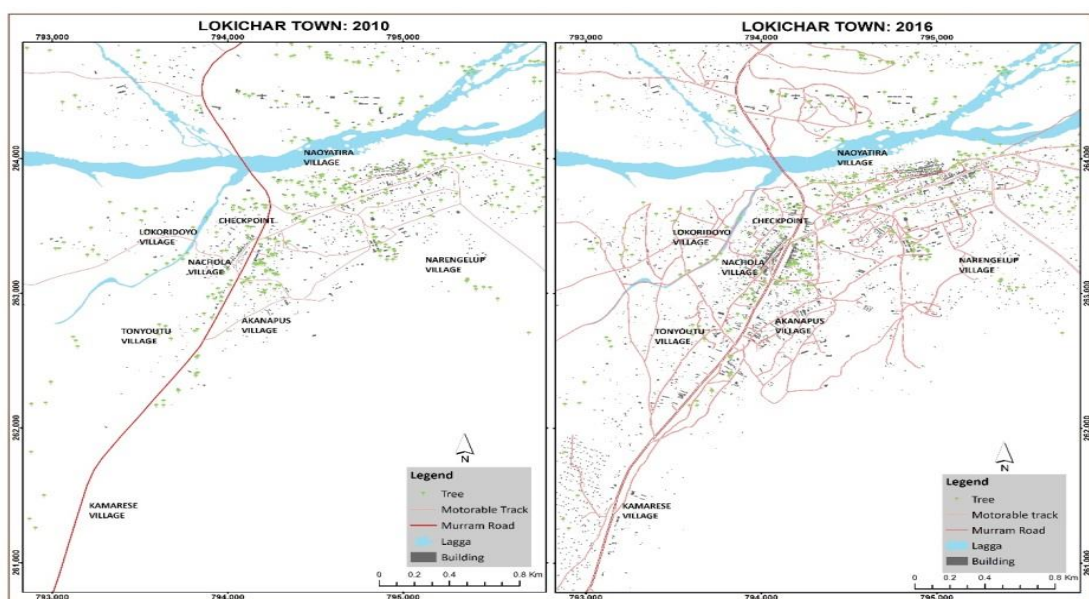


Figure 4.25: Comparative analysis of building infrastructures in Lokichar town in 2010 and 2016 (Data source: Ramani engineering 2017)

The town has experienced an enormous change in the urban population and settlements. Spatial analysis by use of ArcGIS indicated that the total coverage of Lokichar town in 2010 was 5 km² and the town had grown to an area of 11 km² by 2017. An interview with the Turkana County Physical Planner Mr Ewoi Esoit revealed that the spatial planning for Lokichar town was completed in 2016 and that most of the building infrastructures were not in line with the town plan. He noted that implementation of the town's physical plan was a challenge hence uncontrolled development. Figure 4.27 shows the population density of the town and the peri-urban areas. While 2010 situation indicates only one settlement hotspot, 2016 has two significant hotspots with the town spreading Southwards. However, the primary challenge with urban sprawl are the problems that comes with population influx such as waste management, crime, moral decadence, sexually transmitted diseases such as HIV/AIDS as discussed in section 4.4.10. As the town continues to grow, especially once oil production commences if the spatial physical plan is not enforced as noted by the County Physical Planner, the development will encroach into the community grazing areas and this will lead to displacement of the pastoral communities.

The County Government of Turkana has to enforce the county's urban areas physical plan within Lokichar town more so as large scale commercial oil production begins in 2023 which will come with more buildings infrastructural developments. The County Government should also engage the local communities on land acquisition and change of land use. This is because lack of appropriate public consultation and engagement as noted in section 4.4.13 may lead to land resources related conflicts. The town has been experiencing population influx since 2012 and it is expected to intensify once large scale commercial oil production begins. Turkana County has a low population size with the 2009 census report indicating the population size of 855,399 with a total of 123,191

households and 12 persons per square kilometer way much below the national population's density of 66 persons per square kilometer. The population growth rate according to the Kenya Bureau of Statistic web is 6.4% per annum. The table below shows how the population has been growing since 1979 and the projected population size in the county if the fertility and the death rate remain constant according to the Kenya Population and Housing Census (KPHC) 2009 results.

Table 4.13: Turkana County population size and expected growth between 1979-2039

Year	1979	1989	1999	2009	2019	2029	2039
Population size/Expected size	142,702	184,060	450,860	855,399	1,622,248	3,076,563	5,834,643

The estimated current county population size is 1,521,677 (KBS, 2018). Although the population size has been rising in the county for the last ten years, the study observed that several people had moved into Lokichar town in search of the job opportunities and investment. This is evidenced by the fact that the number of the immigrants who had secured employments with the Oil companies in 2014 was 791 national non-locals and 147 expatriates.

The population of the study area has been on the rise since the oil and gas exploration activities began according to the local chief. The growth of Lokichar town as shown in the settlement density map in figure 4.27 is a clear indication of how the investors and job seekers have indeed moved in the area. The study observed that 28% (n=361) of the respondents who were not indigenously born in Lokichar area had moved in the town due to four main reasons. 60% of the immigrants had moved in search of job

opportunities and investment in the oil industry sector as shown in figure 4.26 and 98% of them had settled in Lokichar between 2012-2014.

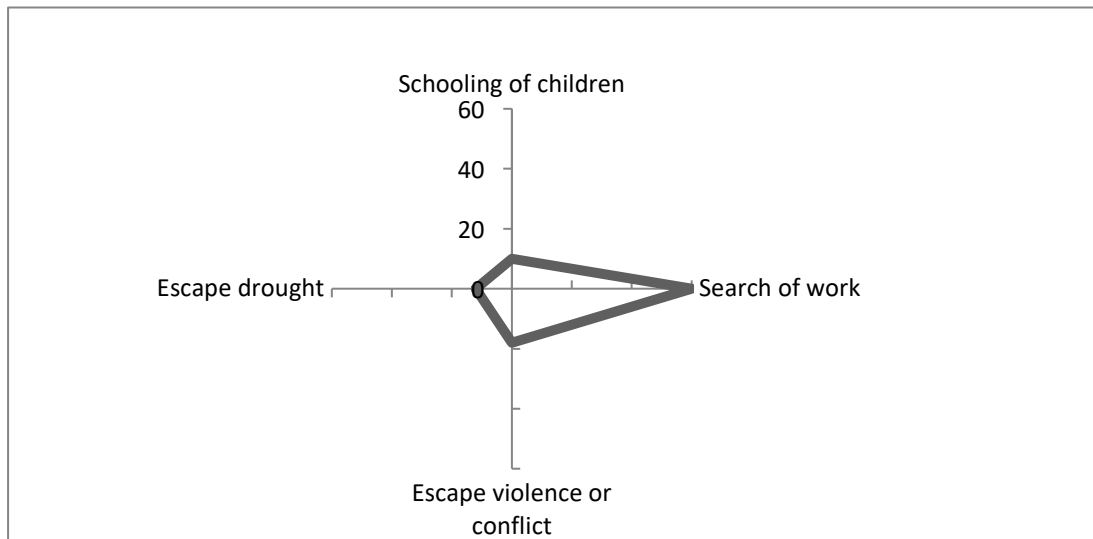


Figure 4.26: Immigrants opinions in percentages on the reasons of their migration into the study area (Data source: Field survey, 2017)

18% of the immigrants had escaped conflicts from their original home and they mostly came from the neighbouring West Pokot and Samburu Counties. 12% of the immigrants had moved in Lokichar in search of food and water, while 10% had moved in search of schools for their children. An interview with the Deputy Sub-County Commissioner indicated that the population influx in the area was projected to intensify with increased exploration work and as production begins. The finding is consistent with Chavunduka & Bromley (2011) who noted that oil and gas exploration and production activities always attract population influx due to the opportunities that come with it. See the population settlement densities of the town in 2010 and 2016 in figure 4.27 below.

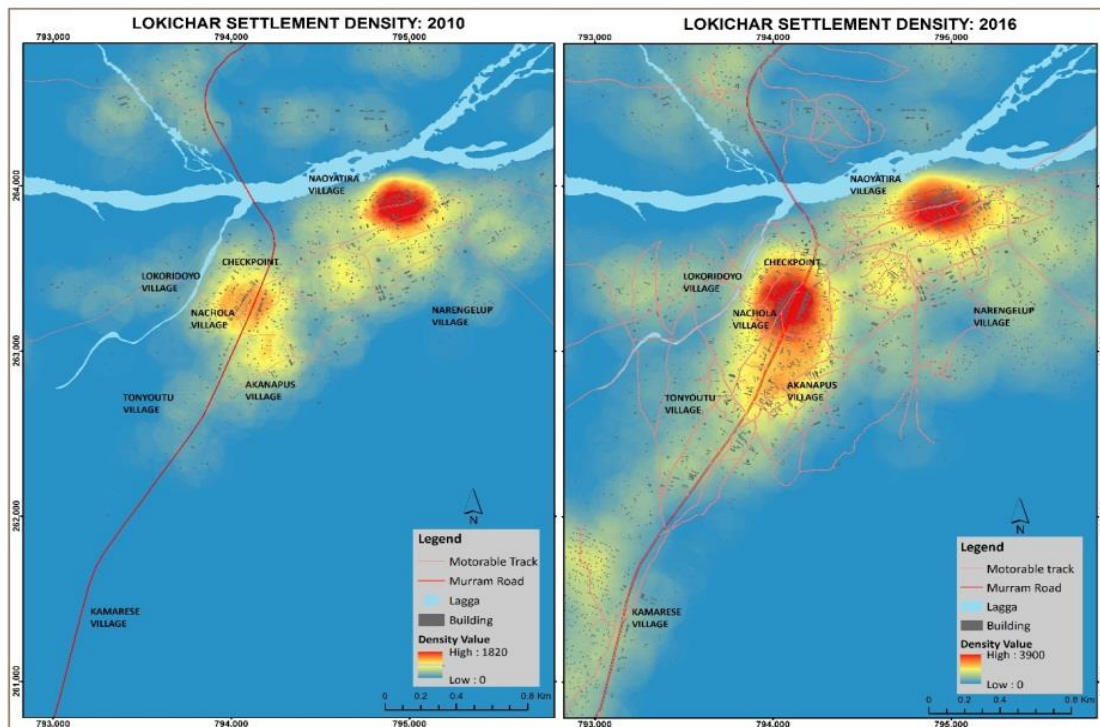


Figure:4.27::Population density of Lokichar town in 2010 and 2016(Source: Ramani engineering, 2017)

According to the local chief, the population influx in Lokichar town has caused some challenges and pressures to the environment. These range from unemployment that has led to increased crime cases as noted in section 4.4.11, to health challenges, and moral decay in the area. The study also established through an interview with the County Director of Environment that generation of the solid waste such as used plastics, used cans and even domestic waste matters within Lokichar town had been on the rise since the discovery of oil in Oil Block 13T South Lokichar Basin. She attributed the challenges to population influx within the area, a problem that may exponentially increase with the onset of commercial oil production. The County Government in its integrated development plan has an elaborate waste management strategy system for the urban areas, he underscored the challenge was on implementation that needed to be improved. Employment of non-locals in the Oil companies directly or indirectly forms

a gateway to more immigrants into the area, as they spread the word on job opportunities and this explains one of the facets of the tragedy of commons theory as noted in section 2.5.4.

4.4.8 Oil and Gas Exploration Effects on Road Infrastructures and Transport Services in Oil Block 13T South Lokichar Basin

The study established that the National Government through KeNHA, KeRRA and KURA, the County Government, and the Oil companies through their CSR projects had invested immensely on road infrastructures of the area. The Key murrum roads done by the County Government in Turkana South Sub-County by 2017 are, Lokabusen- Lomonying- Lokapel road ,GPS coordinates: N 02° 03.819' E 035° 52.421. Naoyarega- Kapelbok bridge, GPS coordinates: N 02° 06.076' E 035° 26.178 Kanaodon-Lokaburu road, PS coordinates: N 02° 29.016' E 035° 24.938 Karoge-Lotunluja-lokaburu road,GPS coordinates: N 02° 24.684' E 035° 33. Kakongu-Lokwamosing road ,GPS coordinates N 02° 01.744' E 035° 31.516143, Kaekunyuk-Korinyang road Fy 2014/015 GPS coordinates: N 02° 14.230' E 035° 33.332, Soped-Lochwaa road GPS Coordinates: N 02° 39.649' E 035° 38.084. A comparative analysis of the road network of the Lokichar ard before the oil and gas exploration activities began in 2010 and after the oil and gas exploration began in 2017 is shown in figures 4.30.

Several murrum access roads to every Well pad in Oil Block 13T South Lokichar Basin had been constructed by the Oil companies. The study established that between February 2014 to April 2018 a total of 250 Kilometres murrum access roads had been constructed by the Oil companies within Oil Block 13T South Lokichar Basin

interlinking the various Well pads and the C46(Lokichar-Amosing road) as shown in figure 4.29.

The Eldoret-Lodwar(A1) highway that passes through the oil fields of Lokichar was under construction according to the information established by this study from the Kenya National Highway Authority, and the tarmacking of the 267 kilometres road had already started by November 2016. The study learnt that different contractors had been subcontracted and were working on different sections of the highway to fast-track the tarmacking process. These contractors are Dittman Construction Limited, Debroso Construction Company, Ravina Agencies, Kiu Construction, Rowla, Assup Enterprise and Frontier Engineering Limited. The construction of this road is to facilitate the transportation of the crude oil using special tankers from Southern Lokichar in Turkana to Mombasa for export as the crude pipeline is being constructed.

An interview with the technical director of the main oil exploring company in Lokichar revealed that the construction of a pipeline for crude oil transportation was quite expensive. He further explained that originally, Kenya had settled on constructing the pipeline to the new Lamu Port in conjunction with the Ugandan Government. However The Ugandan Government pulled out of the plan and this caused a delay to the pipeline project. The Government of Kenya has planned since then to do an 850Km pipeline from Lokichar to Lamu by its own although plans to collaborate with the Ethiopian government to connect Lamu to Addis Ababa through the LAPSSET project have been put in place. Further discussion disclosed that the LAPSSET project would join four countries ; Uganda, Ethiopia, Kenya and Southern Sudan forming the Northern corridor. The project will consist of a Seaport at Lamu, three international airports in Isiolo, Lodwar and Lamu, a Railway line, a Highway, and the Pipeline. The refinery of the crude oil is set to be put up in Lamu. The pipeline project according to the Oil company

officials is expected to cost the government over three hundred billion Kenya shillings. The interview also established that the crude oil in Oil Block 13T South Lokichar Basin was waxy and had high pour point and has to be heated above 63°C for the wax to appear and therefore a heated pipeline with a length of 855 km from Lokichar to Lamu was to be put up for the transportation. The officials disclosed to this study that there were plans to do the de-waxing at Lokichar and therefore plans to put up a de-waxing plant were under way. The cost implication was the only impediment though, and for that reason, transport will be done by road until the project is fully implemented by 2026. Because of this Northern corridor master plan, the routes to access the oil fields in Southern Lokichar were under construction. Though the transportation of the initial crude oil produced was to be done by road, it would be important for the government to fast-track the construction of a pipeline for the transportation of crude oil for environmental safety purposes. Apart from unsafe nature of petroleum product transportation by roads, it is also not very cost effective to perpetually maintain the roads plied by heavy tankers full of crude oil on daily basis.

There is also a need for the government and the Oil companies to fully engage the local communities in a better way to understand the animal migration routes so that the road networks do not alter them so much. The fact that the locals are pastoral and semi-nomadic communities, intensive opening up of the grazing areas may trigger conflicts which may even paralyse the Oil companies operations. The scenario is evidenced by a case shared by an official of a local NGO that took place in May 2017 when activities at Twiga 1 Well pad were paralysed when the local communities and local NGOs blocked the access road. The study also established that in July 2017, the National Government through Kenya Rural Roads Authority had contracted Frontier engineering limited and had started construction and tarmacking of the 30 kilometres C46 Lokichar-

Amosing 1 road, joining A1 (Eldoret-Lodwar) highway at Lokichar town. A survey conducted to the locals on improvements of roads network and transport services within Oil Block 13T South Lokichar Basin revealed that the network and the services had improved since the oil and gas exploration activities began. Figure:4.28 below shows the attitudes of the various interviewees who responded to this query on roads and transport network in the study area.

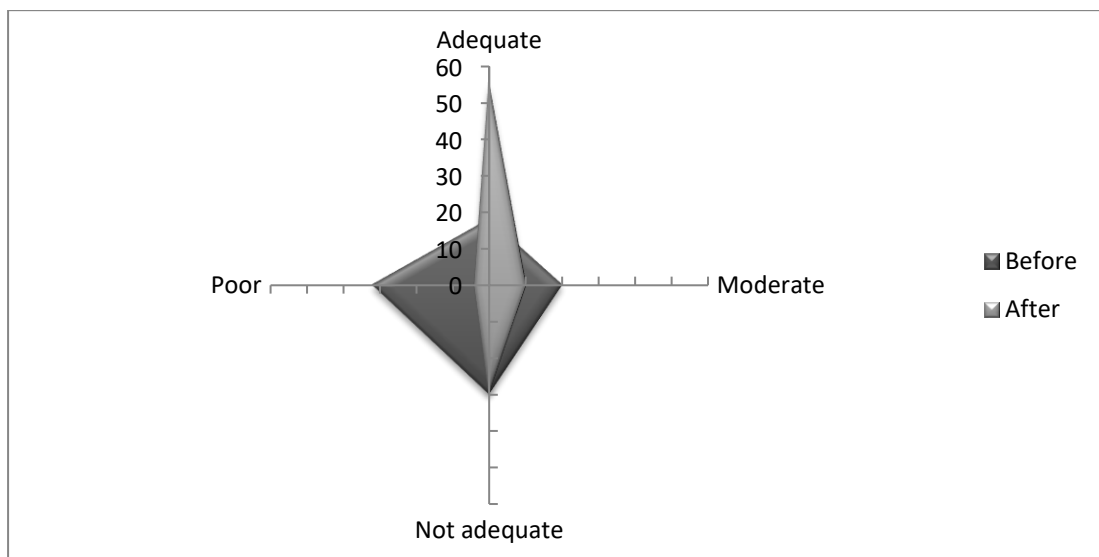


Figure:4.28 Locals opinions in percentages on improvement of roads network and transport services before and after commencement of oil and gas exploration in Oil Block 13T South Lokichar Basin (Source:Field survey, 2017)

56% of all the respondents felt that the roads network in the area was adequate for transport services after the oil and gas exploration activities began compared to 18% who felt that the road network was adequate before the oil and gas exploration activities began 10% Felt that the roads network were moderate after the oil and gas exploration activities began compared to 20% who felt the same for the area before the oil and gas exploration activities began.50% of the respondents felt that the roads were not adequate before the oil and gas exploration activities began compared to the 25% who felt the same after the oil and gas exploration activities started .56% of the people interviewed admitted that the road network was poor before the oil and gas exploration

activities started compared to the 4% who felt it was still poor after the oil and gas exploration activities began. Because the roads were entirely feasible, this study delved into further investigations as to why some people felt that the road network was inadequate. Interviews with the locals revealed that the roads interlinking the Well pads and being used by the locals were murrum roads and they were very dusty and in case of the sporadic rains, they were impassable.

The County Government and the National Government through Kenya Rural Road Authority must invest in the construction of permanent roads for sustainable road transport services networks within Oil Block 13T South Lokichar Basin. The study also noted that the pastoral communities had adversely been affected by these projects. Focused group discussion with the local elders as shown in appendix 7.9 indicated the roads network had affected their livestock migration routes as shown in Plate 4.24 and there were instances that they had lost their animals to speeding vehicles around the oil fields, an experience they never came across before. Listening to these locals, it was clear that the problem was not the actual construction of the roads, but the losses that they perceived to have incurred due to the road networks. See a comparison of the roads network pre and post oil and gas exploration commencement in figure 4.29 below.

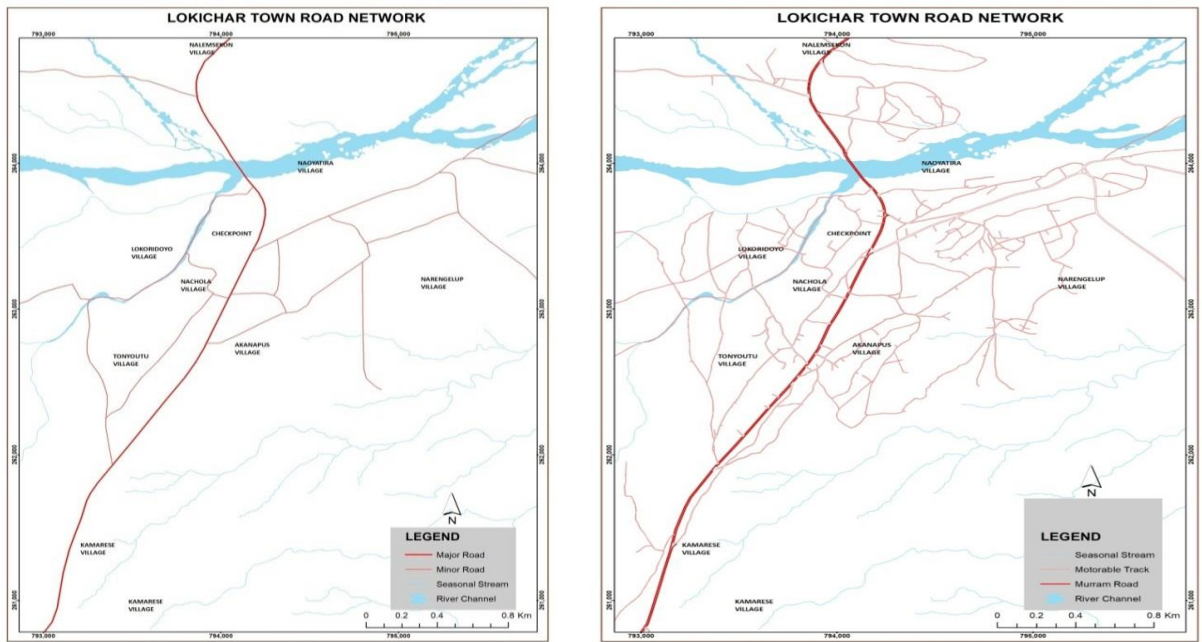


Figure 4.29: Lokichar roads network in 2010 and 2017 (Source: Ramani engineering, 2017)

Figure 4.29 above shows the roads network in the study area in 2010 before the oil and gas exploration activities began and in 2017. The need to open up the various oil Well pads including Ekares 1, 2 and 3, Twiga 1 and 2, Etom 1 and 2, Ngamia 1, Agete 1 and 2 and Emong led to the roads network construction shown in figure 4.29. The study established that Oil companies had constructed and were maintaining the Well pads access roads shown above. The County Government needs to factor in the upgrading and maintenance of the main Well pads access roads since they are still serving the local communities living in the villages.

4.4.9 Oil and Gas Exploration Effects on Revenue Generations of the Business Communities

The study did a pre and post oil and gas exploration assessment of income generation by the four main types of business investment in the study area namely; guesthouses, retail shop business, hotel business and cyber business and the findings were shown in figure 4.30 and Table 4.14.

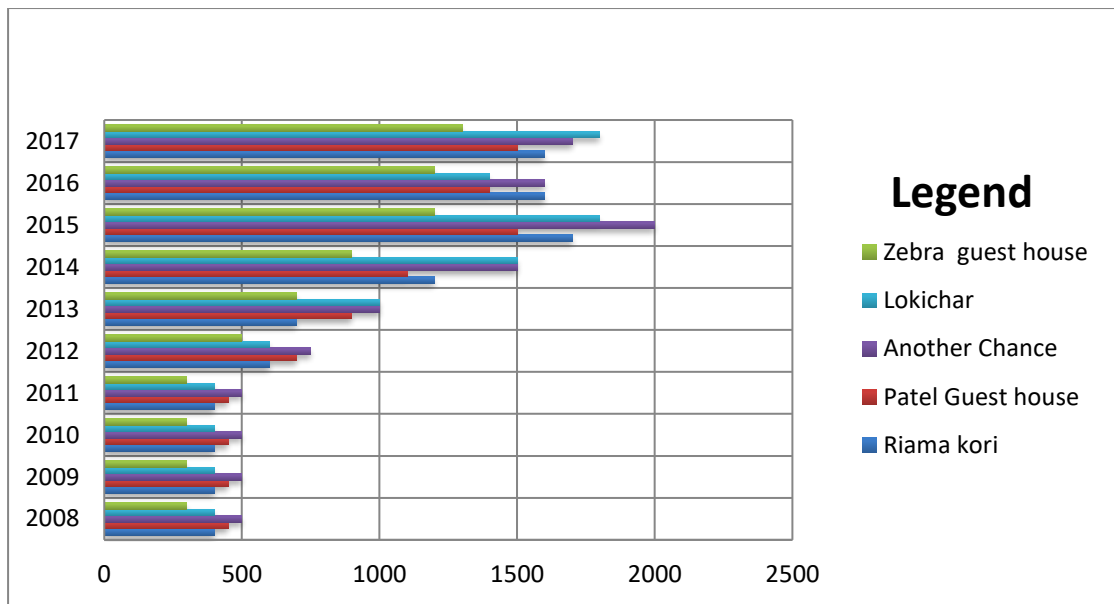


Figure 4.30: Trend of accommodation rates changes of guest houses in Lokichar town pre and post commencement of oil and gas exploration activities(Data source:Field survey 2017)

From the findings, the accommodation fees in the five main guesthouses kept on rising since 2012 due to the influx of guests in the study area. The study established that the accommodation fee stagnated and declined slightly in 2016 as compared to the average accommodation fees for 2015. The study established through the interviews with the guest houses managers that the retrenchment done by the Oil companies operating in Oil Block 13T South Lokichar Basin as noted in section 4.4.5 contributed to the decline and stagnation of the accommodation charges. The findings depict the inconsistent nature of oil and gas exploration related jobs consistent to Evans *etal.* 2016 and Kadafa and Ayuba (2012). The study assessed the average income generated by the eight main retail shops in Lokichar town that had been established by the year 2008 as shown in table 4.14 below. The findings did show a slight improvement in revenues since the commencement of oil and gas exploration activities. The same trend was depicted in the 7 main hotel businesses and the 3 cyber business within the urban centre.

Table 4.14: Revenues generated by the various busines categories in Lokichar town

YEAR	2008	2009	2010	2011	2012	AVERGGE	2013	2014	2015	2016	2017	AVERAGE	
Business						Income Before						Income after	
Retail shops income per month in Ksh													
Huduma shop	110000	120000	90000	100000	115000	107000	125000	150000	160000	155,000	180,000	154000	
Wei wei shop	80,000	70,000	65000	100,000	110,000	85000	130,000	130,000	125,000	145,000	200,000	146000	
Haishi shop	100,000	130,000	110,000	100000	130,000	114000	140,000	135,000	170,000	165,000	160,000	154000	
Anointing shop	120,000	140,000	145,000	120,000	110,000	127000	100,000	170,000	180,000	200,000	180,000	166000	
Acremene Gen.shop	60000	60000	75,000	78000	80,000	70600	60,000	90,000	100,000	95,000	110,000	91000	
Bismillahi shop	100,000	90,000	80,000	110,000	85,000	93000	120,000	110,000	100,000	130,000	120,000	116000	
Bora buyo shop	200,000	220,000	180,000	230,000	250,000	216000	300,000	260,000	240,000	270,000	260,000	266000	
Royals s hop	240,000	190,000	200,000	210,000	190,000	206000	200,000	230,000	210,000	280,000	270,000	238000	
Hotel Businesses income per month in Ksh													
Mashallah hotel	80000	75,000	65000	60000	70000	70000	80,000	90000	85000	100000	95000	90000	
Yasin hotel	100,000	110,000	120000	100000	140000	114000	140000	170,000	160000	165000	200000	167000	
Mama Grace hotel	50,000	60,000	55000	60000	55000	56000	80000	90000	86000	70000	90000	83200	
Ebenezer hotel	50,000	45,000	60000	55000	65000	55000	90000	75000	85000	90000	95000	87000	
Sodokiso hotel	50,000	65,000	700000	80000	65000	66000	50000	65000	70000	67000	60000	62400	
Katamanak hotel	30,000	40,000	50,000	60,000	55,000	47000	55,000	60,000	65,000	55,000	63,000	59600	
Karoke hotel	60,000	55,000	70,000	75,000	60,000	60000	55,000	60,000	65,000	70,000	55,000	65000	
CYBER Businesses income per month in Ksh.													
New Gen. cyber	70,000	80,000	75,000	90,000	85,000	80000	120,000	130,000	150,000	155,000	170,000	145000	
Lokichar computers	100,000	110,000	90,000	110,000	140,000	110000	180,000	220,000	240,000	230,000	250,000	224000	
Galaxy computers	60,000	75000	45000	55000	65000	60000	100000	120000	140000	150,000	140,000	130000	

Source: Field survey, 2017

4.4.9.1 Paired T-Test of Hypothesis on Significance of Commencement of Oil and Gas Exploration on Average Monthly Revenues of the Business in the Study Area

The study hypothesised that there is no significant difference in the average amount of income of various business found in the study area before and after oil and gas exploration, activities began. A Paired T-Test analysis on the income from the guest houses before and after the oil and gas exploration activities in the Table 4.14 above did indicate that there was a mean difference of the amount of income received before and after the oil and gas exploration activities began of 730 Ksh with a standard deviation of 168 Ksh., a standard error of the mean of 75 Ksh and 95% confidence intervals of 521 Ksh to 939 Ksh. The obtained T-value was 9.70 with a degree of freedom of 4. The statistical significance (2-tailed p -value) of the paired t-test was 0.001. As the p -value was less than 0.05 (i.e., $p < .05$) and this indicated a significant difference on the income before and after the oil and gas exploration activities commencements.

The findings were similar on the incomes received from the retail shop business where a paired T-test indicated that there was a mean difference of the amount of income received before and after the oil and gas exploration activities began of 39,050 Ksh. With a standard deviation of Kshs, 137, 37 a standard error of the mean of 4857 Ksh and 95% confidence intervals of 27,566 Ksh to 50,534 Ksh. The obtained T-value was 8.040 with a degree of freedom of 7. The statistical significance (2-tailed p -value) of the paired t-test was 0.000. The p -value was therefore less than 0.05 (i.e., $p < .05$). The statistical significance (2-tailed p -value) for the average monthly incomes of Hotel business with the obtained T value of 2.928 with a degree of freedom of 5 was 0.033. The value was less than 0.05 implying that there was a significant difference in the mean income received before and

after the commencement of oil and gas exploration activities. The mean difference of the amount of hotel business income received pre and post oil and gas exploration activities was 23,300 Ksh with a standard deviation of 19,489 and a standard error of the mean of 7959 Ksh, at 95% confidence interval of 2846 and 43753 Ksh. A paired T-test analysis on the income generated from the three main cyber business in the area indicated that there was a mean difference in the amount of income received before and after the oil and gas exploration activities began of 83000 Ksh. There was a standard deviation of 29962 Kshs, a standard error of the mean of 15,567 Ksh and 95% confidence intervals of 16020 Ksh to 149,979 Ksh. The obtained T-value was 5.33 with a degree of freedom of 2. The statistical significance (2-tailed p -value) of the paired t-test was 0.033. As the p -value was less than 0.05 (i.e., $p < .05$), this too indicated that there was a significant difference on the average amount of incomes received from cyber business pre and post the commencements of oil and gas exploration activities in the study area.

The study concludes that there was a statistically significant difference between the average amount of monthly income generated by the various business in the study area before and after the oil and gas exploration, activities began in Turkana County. This means therefore that the null hypothesis that states that there is no significant difference on the average amount of income earned from the study area business before and after the commencement of the oil and gas exploration activities in Turkana County got rejected. The study, therefore, failed to reject the alternative hypothesis that there is a significant difference on the amount of income earned by the various business investment before and after the commencement of the oil and gas exploration activities in Turkana County

4.4.10 Oil and Gas Exploration and New HIV Cases Prevalence Rate and Moral Decadence in Lokichar Area

An interview with the health officials from Loperot, Lokichar and Locheremoit health facilities in the study area revealed that HIV cases were on the rise since the oil and gas exploration activities began. Data from the Ministry of Health, District Health Information System (DHIS) (2011-2017), validated the findings. Focused group discussions with the local elders and interview with the local chief revealed that the number of commercial sex workers in Lokichar town had upsurged because of the money from the Oil companies. In addition, Mkutu (2018) observed that with the new roads and migrant workers, the sex industry has been growing in Lokichar and in times of drought in particular, adolescent girls are forced to help their families and in this way they end joining prostitution. This has led to an inevitable rise in HIV/AIDS cases in the town. Table 4.15 shows results for the new HIV cases recorded in the dispensaries in the study area.

From the data, Lokichar health centre recorded the highest numbers, attributed to its proximity to Lokichar town where the majority of the immigrants do reside including the rising numbers of prostitutes. The observation is consistent with the work of Kevin *etal* (2010) that population mobility, especially in urban areas, is usually a significant driver of the HIV infections. The numbers recorded for the new cases were exponentially increasing in the three health centres found in the study area. From Table 4.15, except the HIV statistics of 2015, the numbers were on the rise from the year 2012 to 2016.

The study attributed the decrease in 2015 to the retrenchment that was done by the Oil companies due to the financial crisis caused by plummeting global oil prices that reduced cash flow around the study area. The results also show that the highest percentage of the

victims of the new HIV cases fell in the category of those above 25 years of age. The findings could be explained by the fact that, this is the age that provides the workforce in the oil and gas exploration sector, an observation made by Mkutu (2018). Another observation is that women are more vulnerable than men in the same category since they recorded the highest numbers. The fact that Oil Block 13T South Lokichar Basin falls under the marginalised regions of Kenya worsens the situation, since financial challenges in the area may also make the local women more vulnerable.

The young people between the ages of 15-24 recorded the second highest numbers of the new HIV cases, and young women recorded higher numbers than the young men. The findings underpin the report by the local headteachers who indicated that many young girls had dropped out of schools, they had joined the lousy wagon of prostitution, and the men working in the oil industry were luring the girls with money.

Table 4.15: Average number of total new HIV cases in the health facilities found in the study area between 2011 and 2016

	Health facility	Female 15-24yrs	Female above 25yrs	Female under 15yrs	Male 15-24yrs	Male above 25yrs	Male under 15yrs	Labour and Delivery	Postnatal (within 72hrs)	Totals per dispensary
201	Locheremoit	0	4	1	0	6	1	0	0	12
	Loperot	0	0	1	0	0	0	0	0	1
	Lokichar (	23	46	12	2	35	6	2	0	150
Total cases										163
201	Locheremoit	0	4	0	1	1	0	1	0	7
	loperot	3	4	1	0	6	0	0	0	14
	Lokichar (	7	21	6	3	17	9	2	1	89
Total cases										110
201	Locheremoit	1	5	0	0	1	0	2	0	9
	Loperot	11	23	1	14	20	3	0	0	72
	Lokichar	20	17	4	2	27	3	0	0	89
Total case										170
201	Locheremoit	0	0	0	0	1	0	0	0	1
	Loperot	2	17	0	3	13	0	0	0	35
	Lokichar	13	24	8	5	25	4	0	0	81
Total cases										117
2012	Locheremoit	0	0	0	0	0	0	0	0	0
	Loperot	0	0	0	0	0	0	0	0	0
	Lokichar	14	32	5	6	30	11	2	0	116
Total cases										116
2011	Locheremoit	0	0	0	0	0	0	0	0	0
	Loperot	0	0	0	0	0	0	0	0	0
	Lokichar	3	12	3	2	10	3	1	0	50
Total cases										50

(Source: RoK 2017)

4.4.10.1 Pearson linear correlation of the new HIV cases and time in the study area.

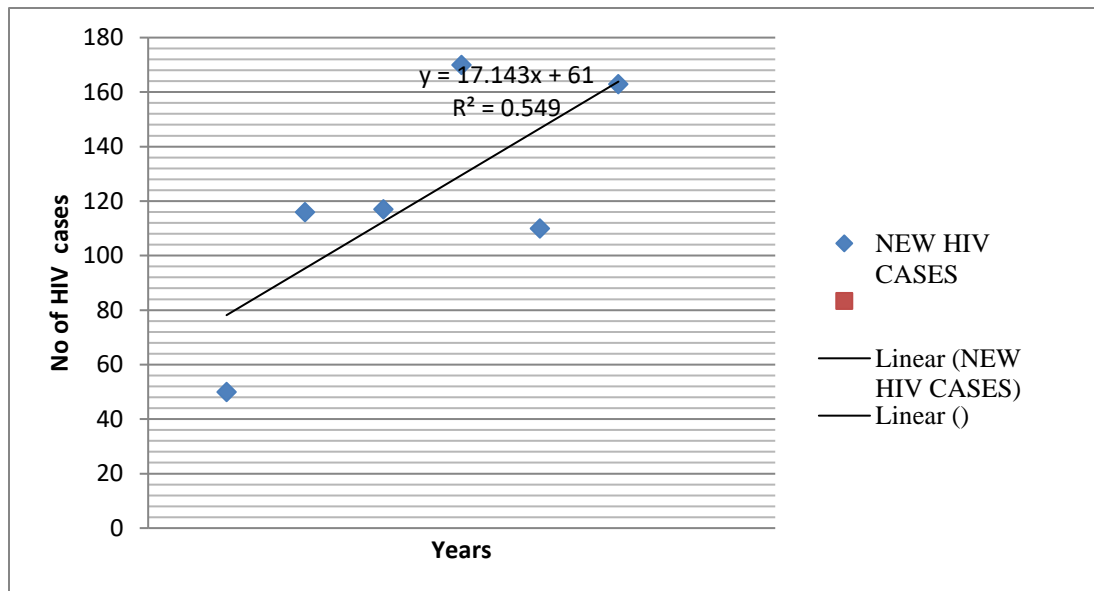


Figure 4.31: Trend of new HIV cases with time in the study area (Data source: RoK, 2017)

An analysis of Pearson linear correlation of new HIV cases in the study area with time indicated a very strong Pearson linear correlation of 0.7409 meaning that the indications increased with time from 2012 to 2016 as shown in figure 4.31 above. This observation contradicts the government 2018 report on Kenya HIV estimates that noted that the prevalence of new HIV cases has been decreasing in Turkana County and between 2012 and 2017 the percentage decline change was -83% since the number of new cases in 2012 were 3141 while the new cases for 2017 were 528. (RoK, 2017). This is opposite of the trend in Lokichar area for the same period of time where the prevalence of new HIV cases increased by 28% as shown in Table 4.15 above. The findings in the report are consistent with the prevalence rate of new HIV cases from other parts of the county whose oil and gas exploration activities have not intensified such as Turkana Central Sub-County. The

study examined the trend of new HIV cases in Lodwar Township by analysing data for the Lodwar Referral County Hospital. The average numbers of new HIV cases indicated that the prevalence rate for the region was declining since 2012 as observed in the aforementioned report shown in figure 4.31. The study also examined the data from Baragoi Sub-County hospital, which is found in the neighbouring Samburu County and the trend, too was on a downward trend pointing to an external factor contributing to the rising trend of new HIV cases in Lokichar area. See the pattern of the new HIV cases for Turkana Central Sub county and Baragoi Sub-County in figure 4.32 below.

4.4.10.2 Pearson Linear Correlation of New HIV Cases versus Time for Turkana Central Sub-County and Baragoi Sub-County.

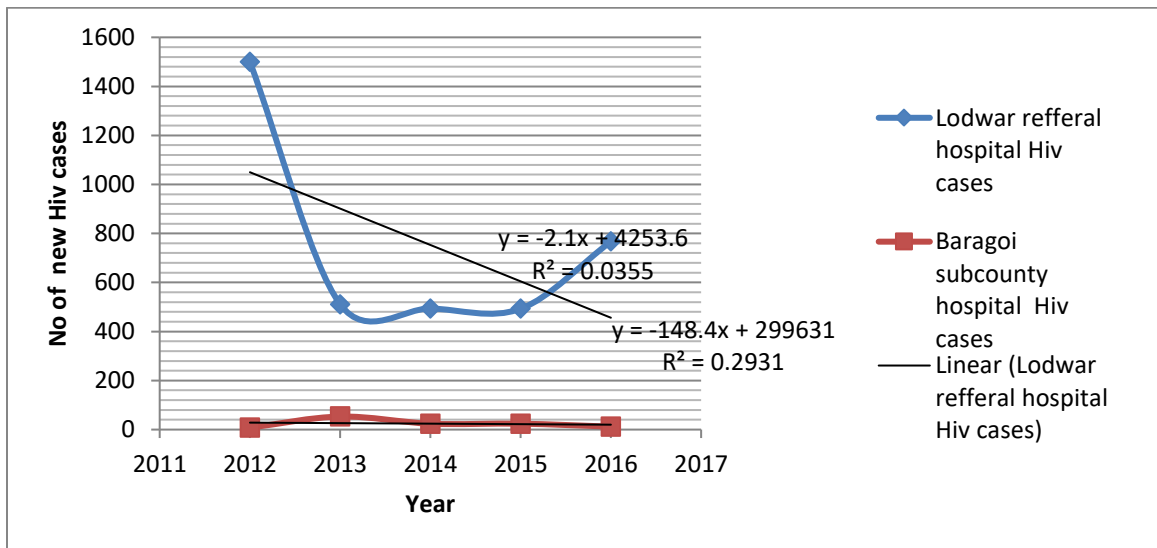


Figure 4.32: Trend of new HIV cases in Lodwar County Referral and Baragoi Sub county hospitals (Data Source: RoK, 2017)

From the analysis in figure 4.32 above, both Baragoi Sub-County hospital and Lodwar Referral County hospital indicated a negative linear correlation of - 0.187 and -0.541 respectively. Apart from the statistics of the year 2016, for Lodwar County referral hospital, which seemed to vary from the previous year's statistics slightly, the data for 2012, 2013, 2014 and 2015 did show a downward trend. The reason for the upward trend in 2016 could be because, the Oil companies according to an interview with the main oil exploring company officials were planning to focus their exploration in Turkana central and Turkana East in the following years, and prospect had already kicked off. As for Baragoi Sub-County hospital, the prevalence rate was on the downward trend and this could be explained by the fact that there were no oil and gas exploration activities yet in the region and therefore no population influx towards the area.

4.4.10.3 A Comparative Pearson Linear Correlation Analysis of the Trends of New HIV Cases from the Health Facilities in the Study Area and Other Health Facilities Outside the Study Area

The Pearson linear correlation between the prevalence rates of new HIV cases in Lodwar and Baragoi hospitals, indicated a strong positive linear correlation with an R factor of 0.898 since as shown in figure 4.33 below the reported average cases were on the decline since 2012 in these two areas. There was a negative Pearson linear correlation (R) of -0.256 of the trend for the total number of new HIV cases for Baragoi Sub-County hospital when compared with Lokichar health facilities.

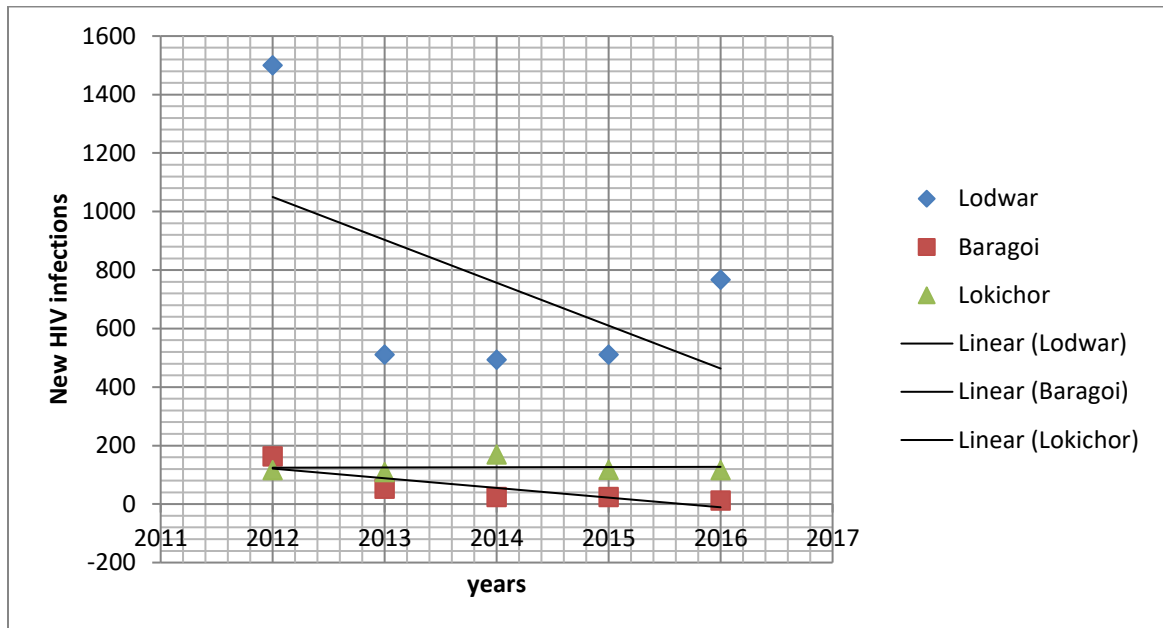


Figure 4.33: Pearson linear correlations of the new HIV cases in the study area and outside study area (Data source: RoK, 2017)

The situation was similar to the relationship of the trend between Lodwar County referral hospital and Lokichar health facilities whose R-value was -0.302. The negative correlation indicates that the trend of the prevalence was moving in the opposite directions as shown in figure 4.33 above, the numbers of the new cases were on the increase in Lokichar health facilities as they declined in both Baragoi and Lodwar health facilities. For sustainable management of HIV prevalence in the study area to be achieved, there is a need for the County Government to develop policies that will ensure allocation of funds in its annual budget to sensitise and educate the locals on HIV prevention measures in conjunction with the local health facilities. There is also a need to invest in the various methods and strategies of protection against HIV/AIDS. Schools in the region need to sensitise and educate their students on HIV since according to the statistics in Table 4.15, most of the victims of this deadly virus are young people. There is also a need to increase the number of voluntary counselling and testing services in the area, and the governments

need to ensure that the antiretroviral drugs are always available to help in the management. An interview with Lokichar chief pointed out another social challenge attributed to the population influx in the area. She revealed that many men from the local communities who had left their families to work in the Oil companies, remarried and divorced their wives, only to be abandoned in 2016 when they got retrenched and many of them were very frustrated.

4.4.11 Oil and Gas Exploration Effects on the Security of Lokichar Area

The study carried out a survey where (n=361) in establishing the status of the security since the oil and gas exploration began as compared to the situation before the oil and gas exploration activities commenced in Oil Block 13T South Lokichar Basin. The responses of the locals were shown in figure 4.34 below. 26% of the respondents felt that the security of the study area was adequate since the commencement of the oil and gas exploration activities in the area compared to 18% who felt that the security was sufficient before the operations began. 30% of the people said that the security was moderate post commencement of oil and gas exploration activities which indicated a difference of 8% with the 22% who felt that the security was moderate pre-oil and gas exploration activities commencement. The percentage of the people who appreciated that the security was not adequate at all before the oil and gas exploration activities began was 40% of all the respondent compared to 28% who felt that still with the oil and gas exploration activities having started and going on, the security was still not adequate. 20% And 16% of the respondent felt that the security of the area was poor before and after the oil and gas exploration activities began respectively. In general 74% of the people who responded felt

that the security of the area was either moderate adequate, inadequate or poor after the oil and gas exploration activities started, compared to the 26% who felt that the security was adequate. 60% of the respondent felt that the security of the area was not adequate or it was poor before the oil and gas exploration began compared to the 44% who had a similar opinion for the security after the oil and gas exploration activities started indicating a 16% improvement of the security in the area since the oil and gas exploration activities began. It is important to note that security is a major issue in Kenya today. Since 2016 there have been inter-communal conflicts in Baringo between the West Pokot and the Tugens and also between the West Pokot and the Turkana. Reports indicate that resources mostly fuel these conflicts. Insecurity has adverse effects on business growth and economic development. According to the Oil Company Director of communications, oil and gas exploration activities came to a halt in 2013 in Turkana East due to uproars from the local communities.

Apart from the domestic conflict issues, Kenya has been a recipient of terrorist attacks in shopping malls, churches, institutions of higher learning and public transport sector where since 2013 so many lives have been lost, and so many Kenyans have been physically devastated. Terrorist group hiding in Somali has been executing these attacks in retaliation to the Kenyan military group fighting them in Somali in a peace restoration mission in the region.

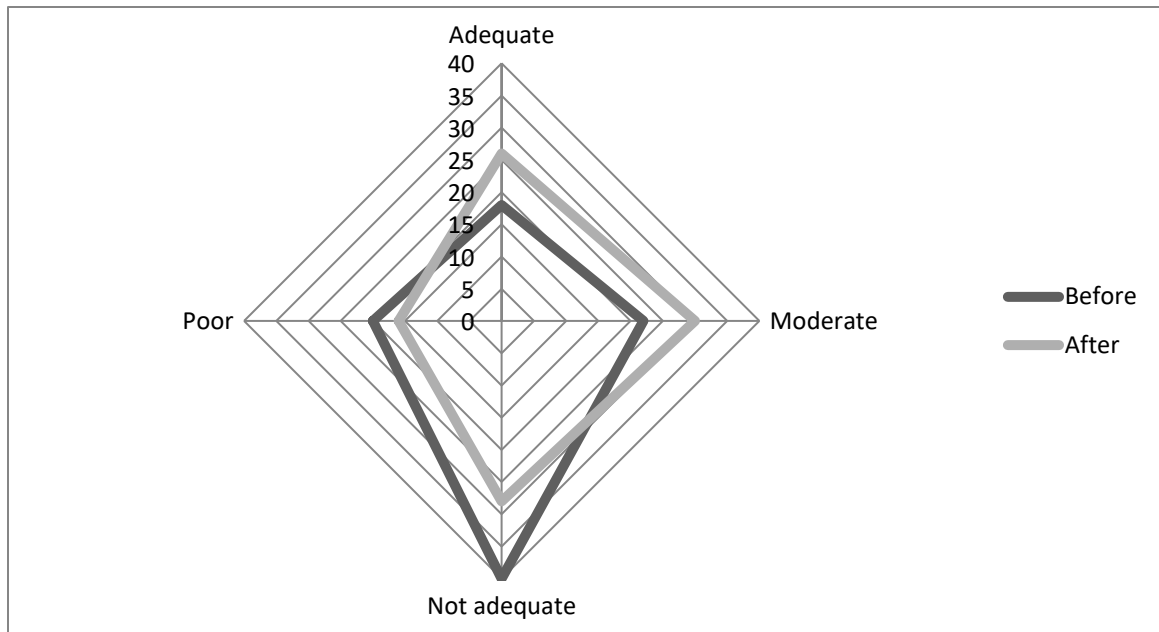


Figure 4.34: Locals' opinions in percentages on security status pre and post-commencement of oil and gas exploration in the study area (Data source: Field survey, 2017)

In September 2013, a group of terrorists invaded West gate shopping mall in Nairobi, the siege took four days, the gunmen did the mass shooting, 70 people lost their lives, and over 175 people were injured. A terrorist killed over 60 people in Mandera in 2014, over 100 people got massacred in Lamu County in July 2014. One of the most devastating incidences was the attack by a terrorist of Garrisa University College in April 2015 where over 163 students were killed. Several crimes have been recorded in different parts of the country. One other unforgettable tragedy that resulted in the loss of over 1300 lives mostly in Rift valley region was the post-election violence of 2007 where tribes arose against each other because of political and ethnic groups affiliations.

The reports indicated that political leaders masterminded these killings. The increased cases of terrorism and other related instances such as violent crimes and conflicts over resources need to make stakeholders in the oil and gas sector in Kenya more vigilant to

ascertain energy security. A survey conducted with some locals who felt that the security was poor revealed that majority of the people who got employed in the oil industry were men, who would leave their children and women behind the villages and when the raiders from the neighbouring community learned this, they intensified their raiding. The local chief disclosed to the study that when the Oil companies retrenched people in late 2015, due to the fluctuating global oil prices, many of the young people found the number of cattle had declined due to the raiders and a large number of them ended up becoming 'ngirukoi', a Turkana name for criminals. These criminals are known to terrorise the locals within the town and the surrounding villages. The study established that in putting up a precaution measure against the terrorist attack, the government beefed up security by deploying more police officers to guard the oil Well pads areas. However, the study learnt from the locals that the police security officers had abandoned them exposed to the cattle raiders from the neighbouring communities and the 'ngirukoi' in the villages as they camped around the well pads.

An interview with the local administrative police personnel revealed that the Kenya police service had recruited the Kenya police reservists to beef up security in oil and gas exploration areas. He further added that a police camp had been put up at Lokichar and over 100 policemen had been stationed there to ensure adequate security in the oil fields. The study established that the beefing up had contributed to increased confidence among the locals within the urban areas and foreign investors in Lokichar town hence the expansion of the town. It is important to note that the town is growing fast and more people are moving in, and this is expected to intensify once oil production activities begin. However, an interview with the programme coordinator of a local NGO revealed

that some KPR officials were being implicated with the carjacking and other criminal acts in the area and along the highway.

This study also established that there had been frequent killing by bandits of the security forces happening at Kapendo area, 60 kilometres from Lokichar town and also frequents cattle raiding around the border of Turkana County and West Pokot County at the Kerio valley even though security has been beefed up in the area. The locals attributed the increased raiding to the abandonment of the villages by the KPR who had embarked in guarding oil fields. The findings of this study in section 4.4.15 show that conflicts cases have been on the rise in the study area which is a security concern. A group discussion with the local elders at Kapese also revealed that the police reservist was not engaging them on matters of the area security. For there to be sustainable security in Oil Block 13T South Lokichar Basin, there is a need to increase the number of police officers even as the population continues to upsurge to protect both the oil fields and the local villages. The officers need to collaborate with the local community leaders, to ensure synergy from the community security personnel.

4.4.12 Oil and gas exploration, Land Tenure and Displacement in Oil Block 13T South Lokichar Basin

An interview with the officials of Friends of Lake Turkana a local NGO and Alemun Pastoralists Empowerment Initiative a local Community Based Organisation, revealed that 30 communities had been affected by oil and gas exploration activities in Oil Block 13T South Lokichar Basin. A focused group discussion with the local elders established that in Turkana County customary land tenure system do exist in which land access is mainly

through inheritance, without formal documentation. The community customarily demarcates land by indicators such as family graves, large old trees and watering wells. Except in urban centres such as Lodwar, Lokichar, Lokori, Lokichogio and Kakuma where the land tenure system is individual tenure the rest of the pastoral land in the County has communal land tenure system.

The study established that the exploration activities had affected an area size of 123794.84 hectares as shown in table 4.3. However, the entire area has not been excavated the Well pads and the access roads have fragmented the community grazing land affecting pastoral activities in the area. This area is part of the Tertiary Rift Basin shown in figure 1.1 and whose Oil Block 13T South Lokichar Basin is a sub-unit. This Basin is among the five sedimentary rock basins that have been divided into oil blocks which have been licensed to different Oil companies. By the end of 2016, a total of 63 oil blocks had been gazetted by the government of Kenya through the Ministry of Petroleum and Mining under Kenyan Gazette notice, No. 3344 covering a total area of 496,464 km². The size of Oil Block 13T South Lokichar Basin which this study focused on is 4,719 km² (471,900 Ha).

An interview with the director of communications in Tullow BV Kenya Ltd revealed to this study that by August 2017, 38 wells had been drilled in Oil Block 13T South Lokichar Basin scattered within a radius of 30 kilometres from Lokichar town. Oil Block 13T South Lokichar Basin had several successful wells drilled by August 2017, and these were; Etom-1, Agete-1, Twiga 1 south, Twiga-south-2 and Ekares-1 and 2, Ngamia 1, Ekares 1,2 and 3, and Twiga 1 and 2, Agete 1 and 2 and Ngamia 1. Four dry wells had been encountered in the study area which are; Ekoswan, Etiir, Cheptuket, and Emong. This study established through an interview with the technical director of the main Oil company operating in Oil

Block 13T South Lokichar Basin that during exploratory and appraisal drilling of oil, a number of activities get carried out on the land. A Well Pad consists of a campsite which do host the derrick, the mud pit for drilling muds preparation, generators and all other facilities needed to support the drilling activities. The average standard of a well pad is 3.5 acres, but a chain-link perimeter fence measuring 5 km by 5km per site is usually erected and an earth berm around the drill sites measuring about 1.5 meters in height are put up as shown in Plate 4.21 below.



Plate 4.21: Well pads with drilling activities going on (Source: Ramani engineering, 2017)

On top of the operation sites created above, the international acceptable common practice in gas and oil developments requires a buffer zone of 1320 feet radius distance between the human settlement or activities and an oil drilling and production operation sites. The study established that the oil Wells pads being drilled in the study area had negatively

affected the local pastoral communities grazing areas. This was demonstrated by the locals responses through a survey and focused group discussions conducted with the elders. Figure 4.35 below shows the locals responses to the effects of oil and gas exploration on their grazing land where (n=361).

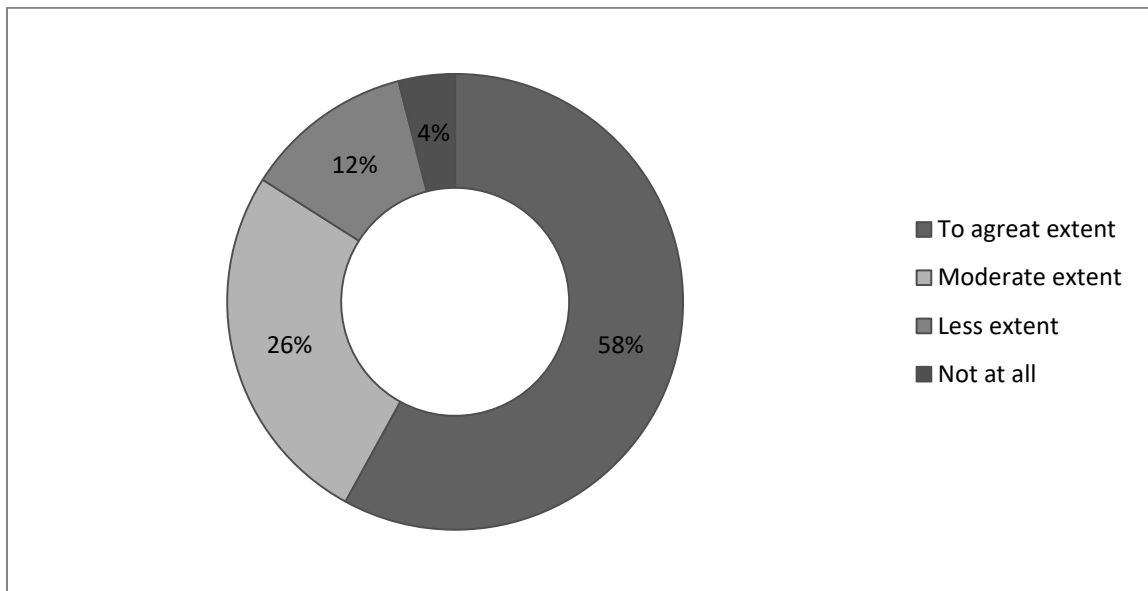


Figure 4.35: Locals' opinions in percentages on displacements from community grazing land (Data source: Field survey, 2017)

58% of all the respondents felt that the oil and gas exploration activities in the study area had affected them to a great extent as far as community land displacement is concerned. 26% of the interviewees said that the oil and gas exploration activities had to a moderate extent displaced them from their land. 12% of all the respondents revealed that oil and gas exploration activities had to a less extent displaced them from their community grazing land. 4% of the respondents felt that the oil and gas exploration activities had not affected their community land ownership through displacement at all.

A cross-interrogation of the attitudes revealed that most of the people who were affected to a great extent were the pastoral communities. The communities used to graze their cattle in land leased to the Oil companies to put up the Kapese ISB offices totaling to 500 acres. Land taken for the construction of the Well pads and access roads had affected a big group of people too. The ISB land was a community grazing land and many households commonly referred to as 'Arumrum' in Turkana would graze their cattle there especially during the dry seasons.

The study further established that majority of the people who indicated that the oil and gas exploration activities had not affected them at all, were town dwellers and most of them had moved to Lokichar in search of jobs and were not pastoralist hence the reason why they were not affected by displacement. Lokichar town is expanding along the roads leading to the Well pads. As the area is already experiencing huge population influx as discussed in section 4.4.7, this expansion is gradually displacing the pastoral communities and it is set to intensify once large scale oil production begins. An interview with Lokichar ward member of the county assembly revealed that the leadership in Turkana has an understanding of the numerous land policy and legislations in Kenya such as the Constitution of Kenya 2010, the Land act 2012 and the National land Policy 2016. According to him, the laws on community land and compensation are yet to be enacted in Kenya, an assertion substantiated by the policy and legislation review in section 4.2. He further explained that there was a significant challenge when it comes to compensation of community-owned land in Oil Block 13T South Lokichar Basin. The study established that before 2015, the Oil companies used to engage the local politicians and members of parliament in whenever they needed to acquire land.

These local politicians are the ones who would facilitate the land leasing process and decide the community projects to be done for compensation. The communities were opposed to the model and the Oil companies since 2015 have formed a single Well pad committee consisting of six members composed of community representatives, a government representative and Oil Company's representative. The mandate of this committee is to deliberate on the nature of the project that should be established with this compensation money. An elderly lady disclosed to this study that following their displacement from the the ISB community land, her children and relatives had moved with livestock in search of pastures to the border between Turkana and West Pokot counties. She indicated that this intensified the cattle rustling by the Pokots communities from the Turkana and that some of her children lost their lives in the process. This study learnt that the communities most affected by the mentioned displacement are the Lotimanan, Lokisim, Ekori, and Kodekode. The findings are consistent with the exposition on demand induced environmental scarcity theory in section 2.5.5. Although the companies committed to acquiring a free, prior informed consent. The study established that the process of acquisition of community land in 2017 for oil and gas drilling, never engaged the local communities and they were not aware of the agreements of the acquisition of their grazing land as discussed in details in section 4.4.13 below.

For there to be a sustainable coexistence, between the Oil companies and the locals regarding the management of the community land in Turkana, there is a critical need to engage the members of the local communities fully.

4.4.13 Locals' Engagement over the Oil and Gas Exploration Matters in Oil Block 13T South Lokichar Basin

The study through an interview with the Director of Communications of the main oil exploring company in Lokichar Basin established that the Oil companies were trying in engagement of the local communities. He noted that the primary challenge was the local politics, where politicians with vested interest would marshal the community members to demonstrate against the Oil companies or paralyse their operations. This would happen whenever personal interest of such politicians such as failure to win a tender service with the Oil company were not met. In addition whenever the local politicians were called upon to mobilise the community members for engagement, they always brought the people that they would easily manipulate or their political cronies and leave out the rest of the community members.

The International Finance Cooperation, performance standard seven sections 2 requires that the Oil companies acquire free, prior informed consent from the locals before they undertake any project in an area. This study established that the main oil exploring company human right policy obligate the company to acquire broad community backing and informed agreement although it lacked guidance on the implementation aspect. A survey to determine the level of the locals engagement and consultation by the government and the oil exploring companies in Oil Block 13T South Lokichar Basin where (n= 361) was carried out and the findings are shown in figure 4.36 below. 72% of the respondents indicated that they were not engaged or involved at all in decision making regarding the various oil and gas exploration activities, such as leasing and acquisition of the communities land or even compensation. 20% of the respondents felt that they had been

engaged to a less extent, 6% recorded moderate engagement, with only 2% saying that the Oil companies had to a large extent consulted and involved them in their exploration activities. The study established that in 2015, the Oil companies received funding from IFC of 50 million USD and part of the contract required that the locals have to be fully engaged before operations begin and were to give free prior informed consent to the Oil companies.

Lack of proper consultation and engagement of the local communities was a significant recipe for conflicts cases as discussed in section 4.4.15. The engagement was vital because the locals' participation over the acquisition of their community land was their constitutional rights; it is also a constituent of the main oil exploring company human right policy and an IFC performance standard indicator that happens to be the Oil companies financiers. The study established that before 2016, the Oil companies were engaging the local communities through the local legislatures and politicians. A model that the communities disliked. They instead formed a Well pad committee with representatives from the Oil companies, the communities and the local chief to be representing the communities. The Oil companies also employed village socialisation officers to link the Oil companies with the locals. Interviews with oil companies officials established that many times the locals especially those that live in 'manyattas' moved from their regular settlement in search of pastures and water for their herds and this made their involvement in decision making cumbersome. They also added that the fact that the majority of the people cannot read or write in English or Kiswahili contributed to a significant number of them not being included in considerable decision-making forums. However, a survey

conducted with some locals who asserted that they were being locked out of engagement refuted the claims.

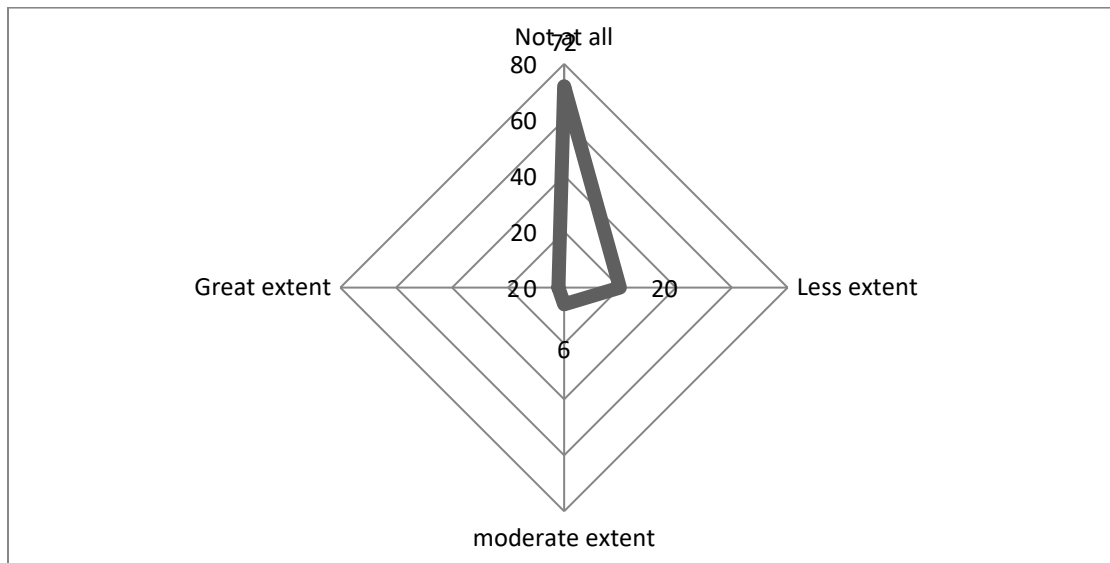


Figure 4.36: Locals opinions in percentages over their levels of engagement by the Government and the Oil companies (Data source: Field survey, 2017)

They indicated that commercial interest from some quarters of the few elite class and the political interests had been the issues undermining the public consultation and this always had skewed participation in favour of a few men and the few local elites. A Focused Group Discussion with the community elders indicated that majority of the locals experienced segregation in decision making over the land and oil and gas exploration matters in Oil Block 13T South Lokichar Basin. They contended that the Well pad committee formed was not a representative of the communities because only the prominent clans were being represented in the committee. These findings are consistent with the study done by Oxfam international in August 2017 that concluded that there was no adherence to the IFC

performance standard number seven by the Oil companies that require free, prior, informed consent from the locals. According to the report, there were no documents or minutes from the Oil companies to show any agreements between the Oil companies and the locals or even a list of people who may have attended the meetings over the acquisition of any land. Also the main oil exploring company and a few people who claimed to have had the documents which were written in English yet the locals cannot understand the language since 82% of the people do not have formal education in the County of Turkana. The report also notes that the Government of Kenya granted the licenses for the oil and gas exploration in Turkana before the communities were aware. The reports also reveal the Well pad committee got formed in 2017. A community leader revealed to this study that, if there were proper community engagement and clarification beforehand on the effects of oil and gas exploration, then some of the conflicts cases being experienced in the area would have been avoided.

There is a need for the Well pads committees formed to provide clear and regular communications within the broader communities. The financiers such as IFC need to bring in a third party as an independent specialist such as a legal adviser to support the communities in the industry and monitoring of free prior informed consent. They should also demand their Oil company's client to build the capacity of the Well pads committee to ensure that they can compile, store and maintain community's engagements agreements. Sustainable engagement can also be achieved by IFC enforcing its contract disclosure requirements to ensure that the communities have adequate information regarding the financial terms of the agreement. The communities need to join forces in establishing routine communications and learning platforms and sharing of ideas and forge

a collective force. Community members need to engage women and avoid segregating them in forging for issues together.

4.4.14 Oil and Gas Exploration and Gender Equality Issues

Documents review approach revealed that Kenya is a signatory to the sustainable development goals whereby goal number five outlines the need for gender equality across the various sectors. The Kenya Constitution 2010 Article 27(8) offers the legal foundation for gender inclusivity in all sectors and spheres in the country. In Kenya, gender inequalities exist across all facets of development, particularly in employment, political inclusivity, poverty, fulfillment of human rights and reproductive health.

The constitution threshold for women representation is 33 %. The study established that communities living in Turkana County are patriarchal societies. A survey conducted in the study area where (n= 361) to determine the locals views on gender equality over oil and gas exploration opportunities and issues had 121 women and 240 men give their views as shown in figures 4.37 and figure 4.38. 83% of all the women who responded to the question on the extent of gender equality on opportunities and engagements in decision making over community land in the study area felt that there was no gender equality at all. They lamented that job opportunities in the Oil companies were being given to men and on matters of decision making it is only men who were mostly engaged by the Oil companies and the Government officials. Most of these women were living in the villages. 10% of the respondents said that the gender -equality was there but to a less extent. 5% felt that the gender equality was there but up to a moderate extent while 2% of the women felt that gender equality was there to a great extent.

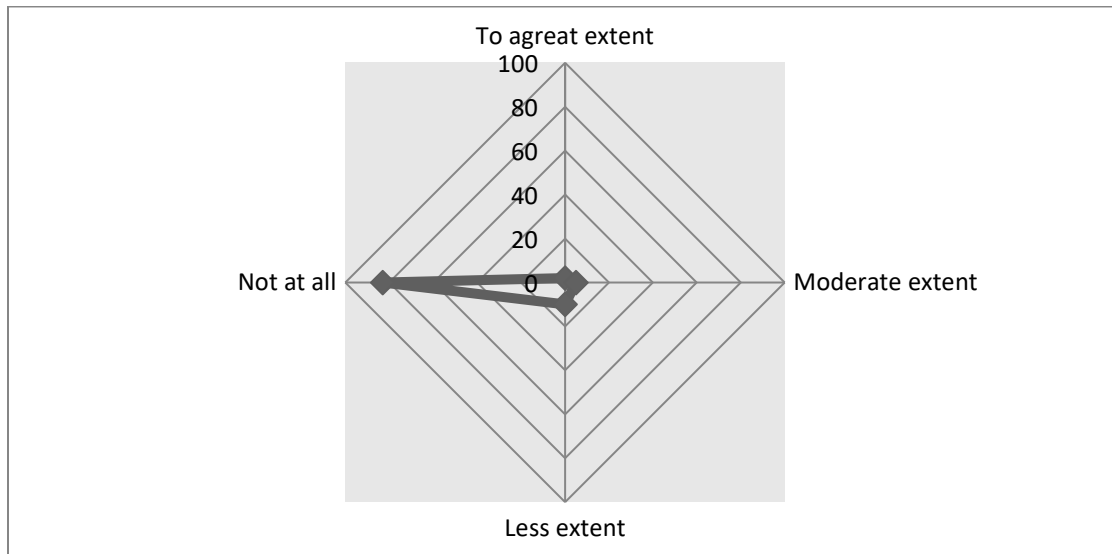


Figure 4.37: Local women's opinions on gender equality for the opportunities in the Oil and Gas Exploration process in Oil Block 13T South Lokichar Basin (Source: Field survey, 2017)

Majority of the women who said that the gender equality was there to a great extent had wages and salary as their main source of income, and this study discovered that they were working with the Oil companies.

60% of the men who responded to the survey said that the gender equality was there to a great extent since they felt that women were well represented. Most of these respondents were from the local communities, a response that may have been informed by their perception towards women. 25% of the men felt that the gender equality was there but to a moderate extent. 10% of the male respondents stated that the gender equality was there but to a less extent while 5% of the male interviewees felt that gender equality was not there at all. The study discovered that majority of the men who said that the gender equality was there but to a less extent and it was not there at all were mostly immigrant in the study area in search of a job and they were not part of the patriarchal Turkana society.

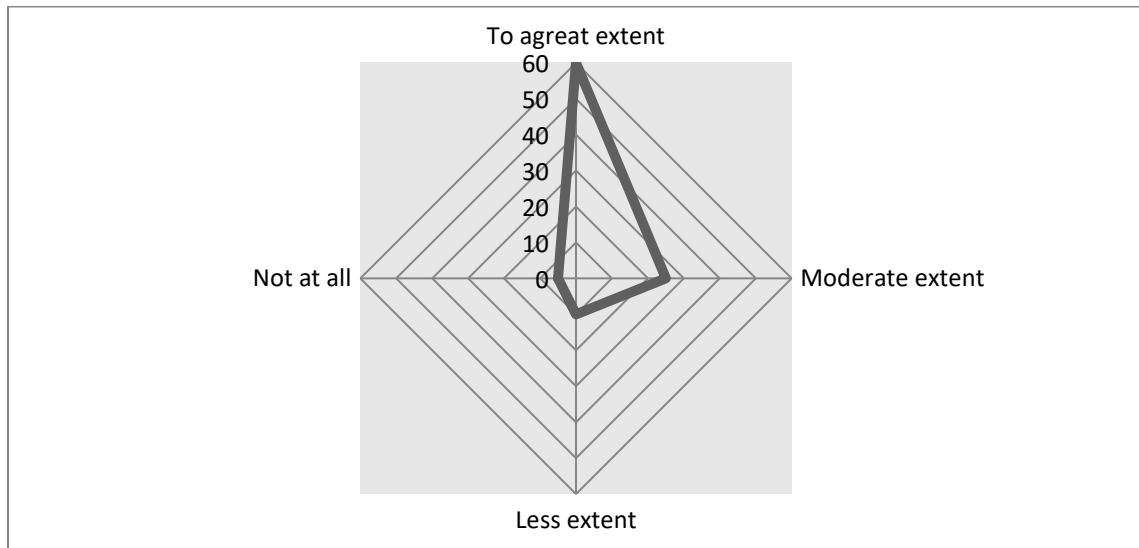


Figure 4.38: Local men opinions in percentages over gender equality for the opportunities in Oil and Gas Exploration processes in Oil Block 13T South Lokichar Basin. (Source: Field survey, 2017)

The study noted that majority of the people who had moved into Lokichar from other counties in search of employment opportunities were men and they are the ones who were working with the Oil companies. As a result, many young women have been taken advantage of and lured with money hence according to an interview done with the women community leaders, cases of unwanted pregnancies have increased. On community engagement regarding land and compensation, women were never engaged, it was a men's affair. The ratio of women to men working with the Oil companies in Oil Block 13T South Lokichar Basin by August 2017 was 1:23 according to the Director of Communications of the main oil exploring company in Lokichar offices. This ratio is too little, and for sustainable development goal number five to be realised, then there is a need for the Oil companies to engage at least a third of all the employees to be women. The study also established that the Well pads committee that was formed to facilitate the Oil companies to engage the local communities on matters of land acquisition and compensation as noted

in section 4.4.13 were made up of men only. These findings are consistent with the study done by Mullins and Wambayi (2017). They noted that according to the traditions of the Turkana communities women are not supposed to sit together with men in deciding on the community. Women are considered inferior. There is a need to educate men in the community to embrace women and acknowledge that they too are gifted human beings. The Well pads committee should build capacities of the communities and have women representatives for gender equality

4.4.15 Oil and Gas Exploration and Environmental Resource Conflict Cases in Oil Block 13T South Lokichar Basin

Turkana communities for a long time have been experiencing inter-clan and transboundary forms of conflicts (Schilling *etal*,2015). They note that transboundary conflicts in the County of Turkana are experienced in all the other Sub-Counties but Turkana North Sub-County. The study established that cattle raiding by the neighbouring West Pokot communities have always resulted to conflicts. Turkana pastoralists communities have developed an adaptive capacity of migrating with their livestock in search of water and grazing pasture resources during the dry season. Through a Focused Group Discussion with the local elders, the study established that the pastrolists from Turkana South move to the border of Turkana and West Pokot where they conflict over water and pastures. The raiders kill at least two pastrolists with every raid and steal hundreds of livestock . The study also learnt that the interclan conflicts conventionally arose from communities fighting with each other within Turkana over water and pasture resources especially during the dry season.

A survey where (n=361) was carried in the study area to determine the locals' view over conflict cases before and after commencement of oil and gas exploration and the responses were shown in figure 4.39 below. 55% of the respondents felt that the number of transboundary conflicts and inter-clan conflicts was very high after the oil and gas exploration activities began compared to the 28% of the respondents who felt the same for these cases before the oil and gas exploration began. 40% of the respondents said that the conflicts cases were high after the oil and gas exploration activities began compared to the 25% who had a similar opinion for the same before the oil and gas exploration activities began. 37% of the respondents felt that the conflicts cases levels were moderate before the oil and gas exploration activities began compared to the 2% of the respondents who felt the same after the oil and gas exploration activities began.

8% of the interviewees said the conflicts cases were low before the oil and gas exploration activities began compared to the 2% of the people who felt that the same after the oil and gas exploration activities began. Out of all the people who were interviewed 2% of the respondents stated that these conflicts were rare compared to the 1% of the people who felt that these cases were rare after the oil and gas exploration activities began. The study noted that most of the people who said that these conflict cases were rare or low had trade or wages and salary as their sources of income and they were living in the peri-urban areas of Lokichar.

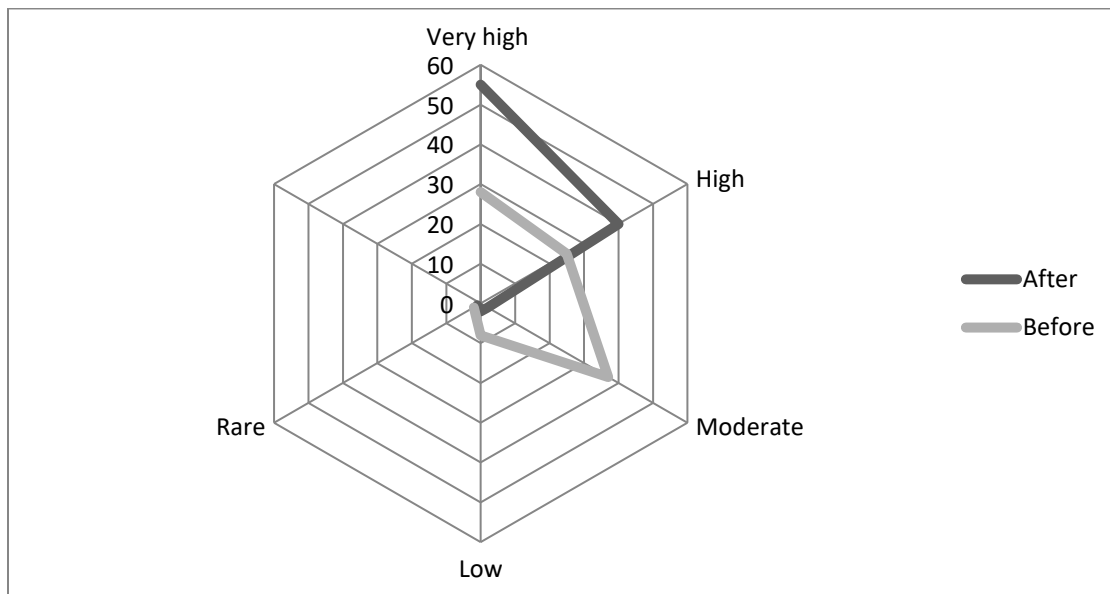


Figure 4.39: Locals' attitudes on the degree of trans-boundary and inter-clan conflict cases experienced pre and post commencement of oil and gas exploration in Oil Block 13T South Lokichar Basin. (Data source: Field survey, 2017)

The study through secondary data from a local NGO; Turkana Pastoralist Development Organization (TUPADO), that keeps data on livestock raids in the County learnt that between 2006-2011, there were between 1-2 raid cases per week and a total of 71 raids per year with a minimum of 2 people dying per raid. The two main forms of transboundary conflicts are the internal conflicts between West-Pokot –Turkana at Kerio valley border and the Illemi triangle transboundary conflict between Turkana-Toposa (a community from Southern-Sudan) and the Karamojong of Uganda. These areas have had the highest intensity raids. The primary source of the trans-boundary conflicts according to the local elders was scarcity of water and grazing pastures. The data did show an average of 20 cases of inter-clan conflicts per year (TUPADO, 2011). The study learnt that these cases have increased to an average of 150 transboundary and 160 inter-clan conflict cases per year since 2012 as shown in figure 4.40 below. Through the local chief and the local communities the research learnt of 3 new emerging form of conflicts between the Oil

companies operating in Lokichar Basin and the local communities. These conflicts arose with the commencement of oil and gas exploration in the area in 2011. The conflicts are related to compensation, employment and tender services between the locals and the Oil companies.

The study learnt through the local elders in the focused group discussions and the Lokichar location chief, that the pathway to conflict resolution was that; the locals report their grievances to the village elders, who report the matter to the local chief. For the conventional inter-clan conflicts resulting from the scarcity of water and pastures, the local chief and the elders manage the conflicts. For conflicts involving the oil exploring companies and trans-boundary conflicts, the local chief informs the Sub-County commissioners who reach out to the Oil companies in resolving the conflicts and for trans-boundary conflicts the Inter-County Leadership and the National Government are responsible for the conflicts management. The secondary data on the conflicts between the Oil companies operating in Oil Block 13T South Lokichar Basin and the locals was gotten from the Lokichar chief and Tullow BV Kenya limited offices in Lokichar town. The average data on all forms of conflicts cases received five years before oil and gas exploration began and five years after were shown in figure 4.40 below.

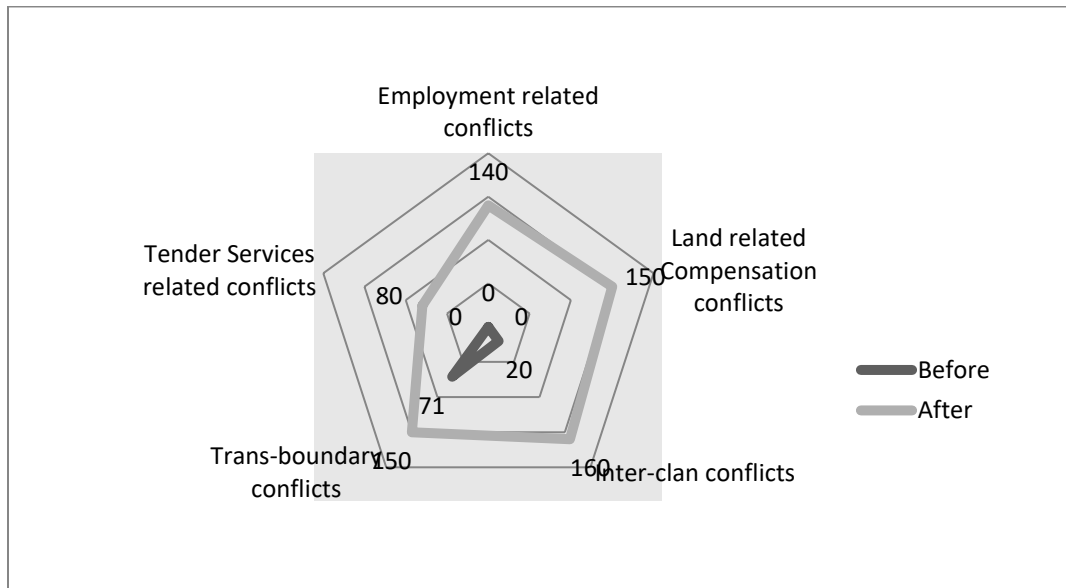


Figure 4.40: Forms and average number of conflicts cases documented in the study area pre and post oil and gas exploration (Data source: TUPADO, Tullow BV, Lokichar Chief, 2017)

The study established that the number of transboundary conflicts cases had risen by 50% to about three every week totalling to an average of 150 cases per year since 2012. In trying to understand how the trans-boundary conflict cases increased with the oil and gas exploration activities, the study through a focused group discussion with the local elders at Kapese village revealed that the displacement of the pastoral communities from their community grazing areas had exacerbated the conflicts cases in the area.

A specific example given to this study was that of the displacement of over five hundred families commonly referred to as 'Arumrum' in Turkana that had settled in the land where ISB stands. The displacement of the 'Arumrum' from the area forced many families to move with their cattle's to the border of West Pokot and Turkana along the Kerio Valley, and this intensified the raiding and transboundary conflict. The study also established that whenever the Cattle has been raided, the numbers always decline, and a good number of

young men in the community who used to take care of them generate to criminals, commonly referred to as 'Ngirototin.' This group of young people had started to pose a security threat in the study area. Young men lose their lives during the raids and the raided family gets subjected to extreme poverty and they have to depend on food aids for their survival

The inter-clan conflicts increased by 800% from 20 cases to 160 cases per annum. According to the area chief and the local elders at Lokichanda, these conflicts in addition to them arising from the scarcity of water and pastures were exacerbated by interclan fights over compensation of a community land. This happens especially when a Well pad falls within the boundary of these two clans. The study learnt of such conflicts between the Kasuroi and Karoge communities over Agete 1 oil well in Southern Turkana in 2013 among others. An interview with the Turkana South Sub-County commissioner revealed that whenever a new well is being drilled such conflict cases always erupted. These findings concurs with Akanji (2012) who reported similar incidents between the Ugbo and Ilaje of Nigeria in 1998. Land compensation related conflicts arose with the commencement of oil and gas exploration. These cases involve the civil societies groups and the local communities versus the Oil companies. The land taken for Well pads, road construction, and office construction by the Oil companies belongs to the community. The study learnt that the locals have been demonstrating and even blocking the various roads leading to different Well pads due to delayed or lack of compensation by the Oil companies for their lands. This study established that there has been an average of 150 cases per year since 2012 according to the data given by the Director of Communications of the leading oil and gas exploration company in the study area. Employment related conflicts of the locals in the oil

fields were very frequent in the area. There was an average of 3 cases arising from different communities per week which totalled to an average of 140 cases per annum. The communities expressed their grievances through demonstrations and blocking various roads jeopardising the companies operations. The locals lamented that the non-locals from other counties had been offered jobs at their expense. The study identified the source of this form of conflicts to be the percentage increase of the national non- local employees in the Oil companies from 29% to 38% and the reduction in percentage of the locals from 65% to 57% as discussed in section 4.4.5.

The business communities in the study area who were supplying various goods and services to the Oil companies conflicted over the timely payments of their invoices, while others complained of biases in the offering of tenders by the Oil companies only to the elite class. As a result, the disgruntled individuals would marshal the frustrated youths to paralyse the companies' operations through demonstrations and road blockage. An average of 80 cases related to supplies and tenders were reported annually since 2012 according to the Director of Communications of the leading Oil Company operating in Oil Block 13T South Lokichar Basin. The study through the youth leaders and the local business communities who sought anonymity established that these Oil companies and the local communities conflicts were mostly fuelled by the local politicians who had their selfish interest which is very consistent with the narrative of the political ecology theory discussed in section 2.5.1. In trying to resolve these conflicts, the companies had employed 20 community liaison officers whose work is to do field outreach programs to the various communities every week as they listen to peoples grievances and report them to the Oil

companies for action. The Oil companies had also employed grievances managing officers to listen to the locals every day in the company's Lokichar offices.

An interview with the Turkana South Sub County Commissioner revealed another emerging conflict between the central government, the County government and the local communities over the sharing of the resources. According to the County official, the proceeds from the oil resources will be shared between the oil and gas exploration companies and the government as per production sharing agreement contract (PSCS). The only issue with this contract signed between the government of Kenya and the Oil companies operating in oil Oil Block 13T South Lokichar Basin, and block 10B is that it is not within the public domain and this means that the exact revenues sharing contract could not be ascertained. An interview with the Director of Communications from the main Oil Company operating in Oil Block 13T South Lokichar Basin established that Oil Block 13T South Lokichar Basin and 10BB agreements were not in public domain, but other blocks were. The interview further revealed that confirmed oil quantities in Oil Block 13T South Lokichar Basin, as per February 2017 were 750 million barrels of crude oil. The levels were expected to hit 1 billion mark by the end of 2018 since the exploration contract had been extended up to 2023 and more exploration work was going on. The study learnt that with a production capacity of 80,000 barrels per day, these reserves would last the country for only 50 years assuming that there were no more discoveries. The study observed that the expectations of the locals for jobs, scholarships, improvement on socio-economic services, infrastructures and environmental sustainability were very high bearing in mind that as per August 2017, the poverty rate in Turkana was at 94.3 % (RoK, 2018). According to Petroleum Act 2019, section 85(2) states that oil revenues will be shared in

the ratio of 5:25:70, between the local communities, the County Government, and the National Government respectively. The study established that the local communities' expectations and demands is that the 5% share that shall be going to the communities should be deposited directly into their bank accounts (Mkutu,2018).The expectation contravenes the National and the County Government plans of using the 5% in setting up communal projects and infrastructures to enhance developments in the area.The study noted that the locals were vowing to bar further oil and gas exploration activities and production in case their views are not respected.Sustainable solutions to the conflicts cases surrounding the oil resource in Oil Block 13T South Lokichar Basin of Turkana County shall only be achieved through proper community engagement. The locals need to be assisted in understanding what this new venture will yield to them, and all the implications it will have on their socio-economic and biophysical environment.

The awareness creation will solve most of the negative socio-economic and negative biophysical effects being experienced in the study area. The legislation on revenue sharing needs to be fast-tracked before large scale commercial production begins in 2022.Legislations on compensation and land displacement need to be in line with the International Finance Cooperation Performance Standards number 7, which demands acquisition of Free Prior Informed Consent (FPIC) from the locals over their community land acquisition.There is also a need to empower the communities in venturing into other economic activities so that they have a diversified adaptive capacities rather than migration with their livestock.A paired T-test on average number of trans-boundary and inter-clan conflicts cases did indicate a significant variation between the average number of cases of

disputes that used to be reported before and after the oil and gas exploration activities began in the study area as shown in section 4.4.15.1 below.

4.4.15.1 Hypothesis Testing on the Average Number of Conflicts Cases Pre and Post-Commencement of Oil and Gas Exploration in Oil Block 13T South Lokichar Basin.

The study had hypothesised that there was no significant difference in the number of conflict cases before and after oil and gas exploration, activities began. From the paired T-test analysis there was a mean difference of the various conflict cases reported before and after the oil and gas exploration activities started of 112 cases with a standard deviation of 44.285 cases, a standard error of the mean of 19.849 cases and 95% confidence intervals of 56.889 to 167.111 cases. The obtained t-value of was 5.642 with a degree of freedom of 4. The statistical significance (2-tailed p-value) of the paired t-test was 0.005. As the p-value was less than 0.05 (i.e., $p < .05$), the study concluded that there was a statistically significant difference between the average number of conflicts cases reported before the oil and gas exploration activities began in Turkana and after. In other words, the difference between the number of conflicts cases reported before the oil and gas exploration activities began and after was not equal to zero. This means, therefore, the null hypothesis; that there was no significant difference in the average number of conflicts cases reported before the oil and gas exploration activities began and after was rejected. The alternative hypothesis that there was significant difference between the average number of conflict cases reported before the oil and gas exploration activities began and after did not get rejected. In conclusion, it is worth to note that the statistical significance on the average number of conflicts cases before the oil and gas exploration activities began and after, is an indicator of the various social, economic challenges that have resulted in the study area due to the new venture. Lack of the community good will eventually paralyse the operations of the

oil exploring companies and investors in the area. It is imperative therefore for the Oil companies and the two levels of the governments to fully engage the locals without using the local elites. They need to make them understand the oil and gas exploration and production cycles, listen to the locals opinions and help to manage their expectations over the 5% community share from the oil revenues once the large scale oil production commences.

4.4.16 Oil and Gas Exploration and its Effects on Livestock Migration Routes in Oil Block 13T South Lokichar Basin

An interview with the executive director of Alemun Pastoralist Empowerment Initiative revealed that pastures and water resources availability mostly influence the nomadic lifestyle of the Turkana community. A focused group discussions with elders at Kapese and Lokichanda villages revealed that during the rainy seasons, the migration of pastoralists is minimal. In the dry seasons the herdsmen follow specific routes, and they especially take their cattle along the river lines or around the hills. They underscored that South Lokichar has been used as a dry season grazing area. As noted in the study area, 38 wells pads have been constructed in the area and access roads and acquisition of the 500 acres ISB land. The elders noted that the oil exploring companies have not specified how much land shall be involved for oil and gas exploration and production hence this has immensely affected their traditional migratory routes. They further observed that they were not engaged by the National Government before the oil and gas exploration activities began yet they are the ones who understand the livestock migration routes. The elders revealed that with the displacement of the locals from their community grazing areas in Oil Block

13T South Lokichar Basin during the dry season, the herdsmen had been forced to migrate towards Kerio Valley and Ilemi Triangle grazing areas and this had intensified the cattle raiding by the neighboring Pokot and Topaso communities hence increased trans-boundary conflicts explained in section 4.4.15. The herdsmen walked long distances before they get to the watering and grazing points and this had resulted in the death of their livestock's alongside the way while others had been run over by vehicles. An interview with the technical director from the main Oil company operating in Oil Block 13T South Lokichar Basin established that the laying of the pipeline to connect every well pad to the crude oil central processing unit in Oil Block 13T South Lokichar Basin may affect the livestock migration route more as compared to the scenario with oil and gas exploration. Plate 4.23 below shows some of the Well pads that have been constructed in Southern Lokichar.

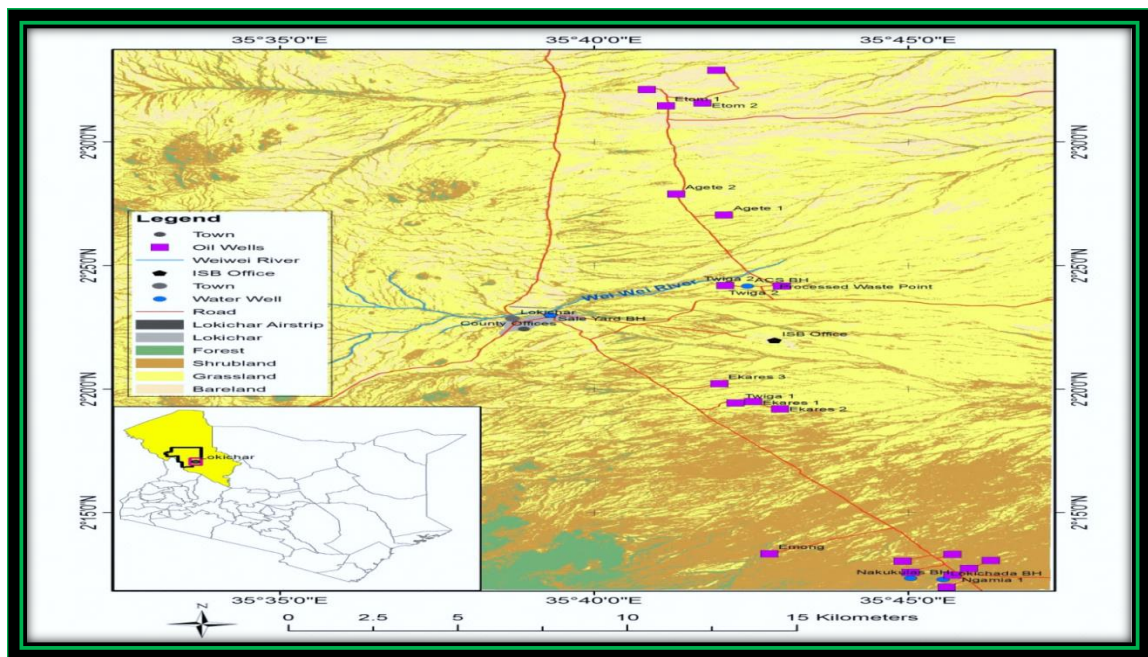


Plate 4.23: Well pads constructed in Oil Block 13T South Lokichar Basin (Source, Acquired and classified from Landsat 8 OLI/TIRS)

The ISB offices indicated on the map is the 500 acres land that used to be a community grazing land for the dry season according to the local elders. The study established that the altered migration routes are as a result of the buffered zones for the various Well pads that hinders any human settlement and livelihoods activity within 1320 meters on top of the minimum 3.5 acres of land fenced for an oil Well pad. (USDI, 2017). The elders emphasised that understanding their livestock's migration routes was very necessary, for it would have guided the Oil companies to avoid the susceptible areas used as migration routes as they constructed the access roads and drill the exploratory and the appraisal wells. See animals crossing a constructed access road that cuts through their normal migration route in the study area in Plate 4.24 below.



Plate 4.24: Livestock crossing a constructed well pad access road (Photo: Researcher, August 2017)

There is a need for the County Government in conjunction with the National Government to map out all the grazing areas and migration routes of the pastoral communities in

Turkana. This will help in minimising the ecological footprint on the locals grazing land and migration routes, which is projected to intensify once large scale oil production commence in Oil Block 13T South Lokichar Basin. The construction of the 855 kilometer crude oil pipeline from Lokichar to Lamu refinery plant (Tullow, 2017), which is a component of the LAPPSET project discussed in section 4.4.8 and the linkages of all the well sites to the central processing unit in Lokichar area will cause more ecological footprints. This is consistent with Pantuliano *et al.* (2009) who observes that the livestock migration routes of the Dar Misseriyya pastoralists community of Kordofan region in Sudan was interrupted

by oil and gas exploration in the region and it led to their loss of livelihoods. Full engagement of the locals who have a clear understanding of the livestock migration routes by the two levels of the governments and oil exploring companies is very critical as they carry out the mapping of these grazing areas and migration routes. There is also a need by the County Government to develop traditional livestock migration route policy to sustainably manage the challenge.

4.4.17 Oil and Gas Exploration Effects on Cultural Resources and Heritage Sites.

The study through a focused group discussion with the local elders established that historically Turkana County has been known to be the cradle of mankind. This means that oil and gas exploration activities were therefore being carried out in an area that is archaeologically, cultural, and social heritage sites sensitive. The study learnt that Turkana communities have a particular affiliation to an array of wild animals and even the oil wells get named after these animals. They gave an example of 'Ekares' that means an Ostrich,

'Twiga' which means a Giraffe, 'Ngamia' which means a camel among others. They feared that the seismic activities and degradation of the dry forest vegetation might eventually cause these animals to die or migrate to other areas and this may adversely affect their culture. The study also learnt that when the herdsmen die or get killed during the cattle raids they get buried in the field where they were killed and therefore oil and gas exploration activities in these areas were destroying their departed kinsmen's graves. A review of the documents revealed that the remains of the early man had been discovered in various parts of Turkana and therefore the protected Well pads by the Oil companies had hindered the open access approach that the archeologists have applied over the years in the discovery journey of the early man. The study also observed that the National Museums and Heritage Act, 2006, oversee the national cultural heritage resources. The Heritage Authority Bill 2015 of Kenya was under deliberation by the National Assembly by the time this study was being carried out and it seeks to repeal the National Museums and Heritage Act 2006 to confirm the law to Kenya's 2010 new Constitution and especially to devolve the roles of management and protection of national heritage resources to the County Government. An interview with an official from the National Museums of Kenya established that there were no procedures and guidelines for assessing and auditing heritage and cultural effects in the oil and gas operations sector.

The study also found that there lacks professional skills in Heritage Resources documentation, mapping, preservation and protection at the county level. Some historic sites whose free access may eventually be affected by the oil and gas exploration site protection include the Namoratunga Pre-colonial burial site in Southern Turkana and South Turkana National Reserve. However the National Museum of Kenya official informed this

study that the law bars any exploration from gazetted sensitive areas of national interest such as archeological sites. The only challenge is on the ungazetted areas which may fall within the oil Well pads since this will limit archeological research. He also expressed his fears that the Government may fail to enforce the protection legislation of these archeological sites in Turkana County due to its economic interest on oil resources. This is depicted by the encroachment of the Nairobi national park by development of the 30 kilometers Southern bypass road in 2013 (Garric, 2015). The development happened despite the prohibition of such projects by the Wildlife Conservation and Management Act 2013. Similar trends have been documented in North Western New Mexico where oil drilling pads have been licensed in Chaco Canyon National Park a UNESCO Heritage Site protected from any development (Houseman, 2017). There is a need therefore for the two levels of governments to implement the legislations on historic, archeological and protected areas in Oil Block 13T South Lokichar Basin for their sustainable management in the backdrop of the oil and gas exploration and production.

**4.4.18 Cohen Kappa Test of Reliability and Agreement of Locals Opinions on
Establishment of Social and Physical infrastructures in Oil Block 13T South
Lokichar Basin**

Table 4.16: Cohen Kappa Test of Reliability

		Physical and social infrastructures after oil and gas exploration					
		Education	Health	Roads	Water	Security	Total
Physical and social infrastructures before oil and gas exploration	Education facilities and services	6	4	16	0	4	30
	Health facilities and services	6	82	8	2	12	110
	Road infrastructures	18	0	56	0	0	74
	Water facilities and services	0	2	0	16	2	20
	Security services	0	8	2	0	44	54
Total		30	96	82	18	62	288
	Value	Asymp. Std. Error	Approx. T ^b	Approx. Sig.			
Measure of Agreement	Kappa	.608	.050	13.095	.000		
N of Valid Cases		288					

Cohen's kappa test which was run to determine the levels of agreement among the respondents over social and physical infrastructures that is water facilities and provision, roads and transport network services, education facilities and services, health services and facilities and security services pre and post the commencement of oil and gas exploration. The study established that there was moderate degree of agreement between the attitudes of the locals in regard to the availability of physical and social infrastructures before and after with a Cohen Kappa coefficient $\kappa = .608$ (95% confidence interval), and since $p = .000$ which actually means $p < .05$, the kappa (κ) coefficient is statistically significantly different from zero. This means that the H_0 ; that there was no significant change on the levels of the establishment of social and physical infrastructures provision before and after oil and gas exploration got rejected and the H_1 hypothesis that there was a significant difference on the levels of the establishment of the social and physical infrastructures before and after oil and gas exploration failed to be rejected.

4.4.19 Intra-Reliability Cronbach's Alpha Test for Oil and Gas Exploration Effects on Community Land, Culture and Livelihoods in Oil Block 13T South Lokichar Basin

Intra-Reliability Cronbach Alpha test for the attitudes of the locals on oil and gas exploration effects on culture loss and displacement from communal land gave the results in Table 4.17 below. The displacement resulted to disputes due to lack of compensation, and interference of livestock migration routes, loss of land and communities livelihoods. The effects were ranked on a likert scale according to the locals' view as having affected them to a great extent, moderate extent, less extent and no change at all. The Cronbach

Alpha coefficient for the ranked effects was .735, suggesting that the items have relatively high internal consistency. A reliability coefficient of .70 or higher is considered acceptable in most social science research situations.

Table 4.17: Cronbach's Alpha reliability test

	Exploration has resulted in culture loss	Exploration, caused displacement of settled communities, causing disputes	Exploration has resulted in the loss of land and livelihoods
Exploration has resulted in culture loss.	1.000	.031	.382
Exploration caused displacement of settled communities causing disputes.	.031	1.000	.514
Exploration has resulted in the loss of land and livelihoods	.382	.514	1.000
Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	No of Items	
.735	.648	3	

CHAPTER FIVE: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Introduction

The general objective of this study was to determine the effects of oil and gas exploration on biophysical and socio-economic environments in Oil Block 13T South Lokichar Basin, Turkana County and come up with recommendations to enhance sustainable environmental management in the area. The specific objectives were to review constitutional, policy, legal and institutional framework governing environmental management in the backdrop of oil and gas exploration sector in Kenya. The second objective was to assess the effects of oil and gas exploration on the biophysical environment of Oil Block 13T South Lokichar Basin, Turkana County. Objective number three was to determine the effects of oil and gas exploration on socio-economic characteristics of the communities in Oil Block 13T South Lokichar Basin in Turkana County. The study adopted the exploratory mixed method research design combining exploratory case study, exploratory descriptive and exploratory post-test only one-shot experimental research design. The research design provided a leeway of triangulation which is the use of numerous means such as data sources, methods and researchers to scrutinise oil and gas exploration and its effects on biophysical and socio-economic environment phenomena in the study area .

5.2 Summary of the Findings

The first objective of the study was to review constitutional, policy, legal and institutional framework governing environmental management in the backdrop of oil and gas

exploration in Kenya. The study established that Kenya has a robust constitution, legislation and policy framework that addresses matters of environmental management. However the study observes that there is a significant challenge in the enforcement by the relevant agencies of Articles 42, 43(1d), Article 69 of the Kenya's Constitution 2010, EMCA CAP. 387 and its subsidiary legislations on waste management, water, soil and air quality, biodiversity conservation, environmental restoration and other international and local environmental laws and policies. The study observed that lack of resources and capacity building coupled with political interference and lack of transparencies to be the major problems affecting these agencies. In addition the study observes that Article 72 of the Constitution of Kenya 2010, acknowledges the need for development of more environmental legislations. In respect to oil and gas exploration and environmental management, there lacks legislations and policies on drill waste management, oil drilling technologies, gas flaring, dry wells restoration, and revenue sharing from oil resources. The Petroleum Exploration Development and Production Act 2017 has not been operationalised hence establishment of Upstream Petroleum Regulatory Authority and Upstream Regulatory Authority Committee which are specific institutions to govern the upstream segment of the oil sector has not been effected. Lack of enforcement of the existing environmental laws and the absence of the mentioned legislations that are specific to oil and gas exploration and environmental management have resulted to negative effects on both biophysical and socio-economic environment in South Lokichr Basin, Turkana County. If measures are not put into place to enhance enforcement by the relevant agencies and develop laws and policies that are specific to oil and gas exploration and production, the

situation may get worse with more oil and gas exploration activities in the area and worse still when oil production begins.

The second objective of this study was to examine the effects of oil and gas exploration on biophysical environment. In regard to the vegetation cover, the study identified that the highest NDVI taken during the rainy season in 2006 was 1 and the lowest NDVI was -0.144 and the value kept on decreasing. By 2017, the highest NDVI value in the study area recorded during the rainy season was 0.4329 and the lowest NDVI was -0.0863. A paired T-test to determine the statistical significance of the NDVI of the vegetation cover of in the study area pre and post oil and gas exploration gave a p-value of $0.0091 < 0.05$ implying that there was a significant change on the vegetation cover between 2006 and 2017. A linear regression of the area under bareland and NDVI value indicated a strong linear regression with a R value of 0.953 and a p-value of 0.012 at 95 % confidence level implying that there was a significant decrease of NDVI as bareland increased.

The area under forest, shrubland and grassland had significantly reduced at 90% confidence interval with a p-value of 0.0718, 0.0738 and 0.0609 respectively. The study in addition observed that dry Well pads were not being restored within the 3 months dry Well pad site restoration which is the EPA recommended period. This was evidenced by four dry wells in the study area that had been encountered between 2014 and 2015 and they had not be restored by August 2017. Vegetation clearance for access roads and Well pads construction in the study area had started to affect the pastoral communities who depend on the indigenous dry land vegetation as forage, according to the local elders, and this calls for sustainable management of the vegetation cover. Failure to adopt horizontal oil drilling technology and instead settling on vertical oil wells drilling technology in Oil Block 13T

South Lokichar Basin, and lack of enforcement on environmental restoration by the relevant agencies has increased the ecological footprint of oil and gas exploration in the study area.

Analysis of the heavy metals of the drill cuttings stored at Twiga 1 Well pad revealed that the concentration levels for Manganese, Iron and Lead were all above the WHO recommended standards for a reserve pit and this is an environmental contamination hazard. The average levels of Iron, Nickel, Turbidity, Total dissolved solids and P.H from the communities boreholes water were all above the levels recorded by similar studies done in 2011 and 2012 and were above WHO and USEPA recommended standards for human consumption. Document review for soil samples taken around Twiga 1 in May 2017 did show that the values for Zinc and copper were all above the values recorded in for the same area before oil and gas exploration begun. Other metals that were detected in the soil sample analysis in 2017 but they were not detected in 2012 soil analysis were, Nickel, Mercury, Chromium. Although the levels of these metals are within the globally accepted Dutch Intervention soil values, they were not detected in the soil sample analysis done before commencement of oil and gas exploration. One may be drawn to conclude that there was a likelihood of pollution from oil and gas exploration drill waste materials. The study noted that the nearer the soil sampling point was from the drill cuttings reserve pit, the higher the concentration of heavy metals detected. Cronbach Alpha Intra-Reliability test of the locals' opinions on the effects of oil and gas exploration on biophysical environment was 0.636 indicating a moderate degree of agreement. The study also observed dust particles emissions and flaring of gases during the testing of appraisal wells that portends sources of air pollution. The study established that the environmental

management monitoring agencies are not in a position to effect their monitoring mandate of proper waste management soil,air and water quality due to lack of capacity and resources.The area is remote and there lacks facilities such as laboratories and vehicles to access the oil fields.Lack of oil and gas exploration and production waste materials management specific legislations has also contributed to poor management of drill cuttings and the situation shall worsen with oil and gas exploration intensification and commencement of oil production.Moreover the study observed that the international oil and gas exploration financiers such as IFC were not very active in the oil fields to monitor environmental sustainability for the projects they had funded in Oil Block 13T South Lokichar Basin.

The third objective of this study was to determine the effects of oil and gas exploration on socio-economic characteristics of the locals. The study observes that oil and gas exploration has brought with it several social and physical infrastructures development projects in the area.These includes;electricity,water,education,road infrastructures,security and health projects. The Cohen Kappa reliability test coefficient of the locals' attitudes of the establishment of education, health, roads and transport network, water provision and security facilities and services pre and post commencement of oil and gas exploration was 0.608.This indicates a significant level of agreement among the locals of the established services and facilities. The study established that the Oil companies had spent 0.5 Billion Ksh. on social investments within Oil Block 13T South Lokichar Basin between 2013-2017. The National Government and the County Government too have invested in socio-economic infrastructures to facilitate oil and gas exploration and production activities in the area.People's income and business revenues have really improved in the

study area. However the study observed several socio-economic challenges. Despite the fact that 200 homes and 400 businesses had been connected to the national grid electric power by August 2017, many people, especially the ones living in Manyattas, may not benefit from the electricity due to lack of capacity to pay the monthly electricity bills hence the need for a more sustainable source of electricity such as solar energy. In trying to solve the water problem in the study area, the Oil companies by August 2017 had installed 30 water storage tanks in the villages with a capacity of 10000 litres each, and this had reduced the movement of the pastoral communities around the oil and gas exploration areas in search of the water resource. However, contracted water tankers were refilling these tanks daily. This approach of managing water problem in the area may not be sustainable since the Oil companies can only sustain it as long as they are making profits and there is a goodwill from the locals. Even though there is improvement in health services and facilities in the area, there is a rising trend of respiratory, skin and eye infections in the area, health conditions that the health professionals in the area are linking to a probable air and water pollution from oil and gas exploration activities.

On education matters despite the numerous education projects and scholarships awarded to students in the area, challenges such as, the beneficiaries of the said scholarships having graduated with oil and gas related courses and had not secured jobs, construction of community schools by the oil companies but the locals are not able to employ trained teachers who happens not to be available in the area, young people dropping out of school to provide cheap labour in the oil industry and unwanted pregnancies among the young girls were on the rise since oil and gas exploration begun as they get lured with money by

men working in the oil fields, a situation that may get worse with intensified oil and gas exploration and commencement of oil production.

Although economically, majority of the locals' incomes and business revenues had improved due to oil money, the study observed that fluctuation of the global oil prices led to decline on business revenues and loss of jobs for people working in the oil and gas exploration sector in 2015. Majority of the workers had abandoned their traditional sources of livelihoods and secured unskilled and semiskilled jobs in the oil sector. Other challenges noted entails population influx in Lokichar town in search of job opportunities, an issue that is contributing to rising crime, and increased cases of sexually transmitted diseases such as HIV/AIDS. Moreover gender inequality in job opportunities and tender services, interruption of livestock migration routes by the constructed Well pads and access roads, failure by the oil companies to pay the contractors, employment of the community members and displacements of the locals from their community grazing land without proper engagement and compensation an issue were other problems noted. Poor engagement of the locals, displacements, poor compensation for their land has led to increased conflicts between the locals and the oil companies, increased inter-clan and transboundary conflicts due to limited water and forage resources. A paired T-test to determine the statistical significance of the average number of conflicts cases reported before and after oil and gas exploration did show that the p-value calculated was 0.005 which was < than 0.05 indicating a significant change on the increased number of conflict cases in the area. Lack of awareness of the cyclic nature of the oil sector jobs is causing many locals to abandon their traditional sources of livelihoods. Lack of adequate engagement of the locals by the governments and the oil exploring companies have resulted

to increased conflicts in the area and this comes in the backdrop of Article 69 of the Kenya's Constitution and IFC performance standard one(PS1) that the oil companies admitted to have prescribed to, demanding for adequate public participation.72% of the locals revealed to this study that they had not been engaged or consulted on any issue regarding the oil and gas exploration at all in Oil Block 13T South Lokichar Basin,Turkana County.

5.3 Conclusions

The institutional theory adopted in this study highlights the role of constitutional,policy,legal and institutional framework in sustainable governance of environment in the backdrop of oil and gas exploration.The study findings confirms that lack of adequate environmental legal and policy framework and scant enforcement by the relevant institutions leads to poor biophysical and socio-economic environmental management in the oil exploration and production sector.Based on the findings of this study, there exist gaps in the existing Kenyan environmental legal and policy framework specifically in relation to oil and gas exploration and production.The mentioned gaps in law have contributed to the biophysical and socio-economic problems being experienced in Oil Block 13T South Lokichar Basin in Turkana County.

In addition, the study establishes that environmental laws,enforcing institutions must be proactive and must have enough resources and capacity for them to be effective in ensuring sustainable environmental management. This is evidenced by the admission by the mentioned agencies in the study area to lack enough capacity and resources to do regular monitoring of air,soil ,vegetation cover and water quality in the oil fields.As a result

the study noted four dry wells in July 2017 drilled in the year 2014/2015 in the study area despite the requirement by the local legislations, multilateral environmental agreements and best practices standards for a dry well restoration within 3 months. In addition the improper storage of the drilling waste materials in the study area, lack of public participation of the locals over oil and land issues and lack of annual environmental auditing data on water, soil and air quality as stipulated in the environmental laws ascertained the agencies assertion and the study's findings.

The study has shown that in the absence of a legal framework guiding on the adoption of an ecologically friendly horizontal oil drilling technology, the conventional vertical oil drilling leads to increased ecological footprint and destruction of vegetation cover. This is evidenced by a Two-sample T-test on the size of the different land cover changes in hectares pre and post oil and gas exploration in Oil Block 13T South Lokichar Basin that indicated a significant decline in size. In addition a paired T-test for the NDVI of the study area pre and post oil and gas exploration for both dry and rainy seasons did show a significant drop in NDVI value. This implies the degradation effect of the vegetation caused by the oil and gas exploration process and this is subject to intensify with more exploration and production. Furthermore, the study shows that drill cuttings, natural gases mixed with impurities, dust mixed with volatile organic compounds and used drilling fluids are the leading waste materials generated from oil and gas exploration drilling activities and they are all potential environmental pollutant. Drill cuttings forms the bulk of the waste material and they are rich in heavy metals and other chemicals and needs to be managed sustainably to avoid water, soil and air pollutions which have severe human health challenges. The study investigations shows that the drill cuttings management, in

the study area is a major challenge. This is because drill waste from the entire Oil Block 13T South Lokichar Basin was being stored at Twiga 1 Well pad for more than the recommended time portending an environmental contamination hazard. Moreover, an analysis of heavy metal contents did show levels above the recommended standards for the reserve pit. However, of great concern are the high levels of heavy metals in the soil samples taken around Twiga 1 Well pad and also boreholes water samples from the study area which suggests a likelihood of contamination. Gas flaring which is associated with air, noise and light pollution was observed too in the study area and this will intensify once oil production commences. One may be drawn to link the increasing cases of respiratory, skin and eye infections in the study area to the waste management problems in the area.

In addition, the study findings shows that venturing in oil and gas exploration results in both positive and negative socio-economic effects. Positive socio-economic effects entails development of the social and physical infrastructures including improved incomes for those working in the oil and gas exploration industry. This is evidenced by Cohen Kappa test of reliability of the locals' opinions on the establishment of the social and physical infrastructures pre and post oil and gas exploration commencement that was significant in the study areas. A Chi-square test on the locals income before and after oil and gas exploration begun, indicated a significant change. Furthermore a paired T-test on the revenues of the different business ventures indicated a significant change. However the study findings also shows that oil and gas exploration leads to several negative socio-economic challenges as evidenced by intra-reliability Cronbach's Alpha Test which was significant for the following, identified negative, land displacement, population influx

tampering with the locals culture,increased crime,communicable diseases such as HIV,increased school dropout, moral decadency,loss of livelihoods caused by land degradation and interruption of animal migration routes.Others are inability of the oil companies to employ everyone from the locality, retrechment due to the cyclic nature of oil jobs, lack of compensation to the communities for their land,delayed payment to the local contractors by the oil companies and lack of engagement of the locals by the oil explorers and the governments.Eventually these problems result to increased number of conflicts cases as evidenced by the Paired T-test analysis for the number of conflicts cases pre and post oil and gas exploration that indicated a significant change,implying oil activities had led to increased number of conflicts due to the mentioned problems.The conflicts paralyses the operations of the oil companies and cause interclan and interboundary clashes due to land displacement that leads to scarcity of resources consistent with environmental scarcity theory adopted in the study.This outcome shows that oil and gas exploration causes both biophysical and socio-economic environment effects.Sustainable management of these environments will only be realised if there is an effective constitutional,policy,legal and institutional framework governing environmental management in the backdrop of oil and gas exploration, consistent with the sustainable livelihood theory whose this study was based on.The methodology adopted for the research contributes to the realisation of the studys' objectives.

5.4 Recommendations

Recommendations made in this section are derived from the conclusions about the study's findings as presented in the previous section and focus on the direct interventions. It is the

view of the researcher that the recommended solutions could help address the constitutional, policy, legal and institutional framework, biophysical and socio-economic environmental challenges in South Lokichar oil fields to ensure sustainable environmental management in the backdrop of oil and gas exploration.

- i. Lack of enforcement of the constitutional, legal and policy framework by the relevant government agencies is a major hindrance to sustainable management of environment in South Lokichar oil fields in Turkana County. This has resulted to poor monitoring of environmental quality, poor implementation of Constitution of Kenya 2010, Article 69(1) on public participation and Article 27(3) on gender equality. The government agencies attributed their inability to lack of enough resources and capacity. This problem can be addressed by the national and the county governments liaising in allocation of enough resources and investing in capacity building and recruitment of more staff members for the Government agencies such as NEMA, DOSHs and WRA among others. Basing these officials in every sub-county and investing in mobile laboratories and vehicles to access remote areas such as South Lokichar basin would enhance enforcement. This is because it will ensure appropriate regular monitoring and assessment of the environmental effects of the oil and gas exploration activities in the oil and gas exploration fields. This in return will ensure environmental restoration and minimise environmental pollution such as air, water and soil pollutions. It will also ensure gender equality, public participation and engagement is adequately carried out and this would reduce conflicts in the oil fields. In addition the international financiers such as IFC need to improve on their monitoring on environmental sustainability for the oil and gas exploration projects they finance.

- ii. There is a gap in environmental management legislations specific to oil and gas exploration process. Legislations specific to oil and gas exploration processes are very key if sustainable management of environment is to be realised in the oil fields, not only in Kenya, but in all developing countries. These specific legislations that need to be developed include, drilling generated hazardous waste management addressing problems posed by drill cuttings and adoption of technologies such as TDU and phytoremediation in their management. Other legislations are those addressing gas flaring challenges especially as exploration intensifies and production begins. Operationalisation of Petroleum Act 2019 needs to be fast-tracked by the government for it will create specific institutions to handle the upstream oil segment. In addition, a legislation guiding oil exploring companies to adopt more ecologically friendly technologies in oil drilling, such as horizontal drilling to minimise ecological footprint especially in Turkana County, where the communities depend on pastoralism as the primary source of livelihoods in future exploration and production ventures is very critical.
- iii. Oil and gas exploration venture has several positive effects such as developments of social and physical infrastructures, job creations and many more. However if not sustainably managed, they may not benefit the locals. This can be realised by the county government developing policies that will ensure sustainable management and utilisation of the various physical and social infrastructures that have been put up in the area. These include investing in solar energy for the locals who cannot manage to sustain the payment of national grid electric bills, partnering with the oil companies in tarmacking and maintenance of access roads to the various villages constructed by the oil companies to access their Well pads as they will serve the locals. Policies on partnering with the oil companies and other investors

in developing sustainable water sources such as extraction of water from deep water aquifers or pumping water from river Turkwel. The county government also must develop policies on acquisition of the community schools built by the oil companies and liaise with the National Government for their sustainable management. The county government must employ more medical staffs to deploy to the various health facilities constructed by the oil companies and ensure that they are well equipped to help in management of emerging health issues related to the oil and gas exploration and production. The county government must integrate the fight against HIV in their environmental protection programmes in Oil Block 13T South Lokichar Basin. The local schools need to develop an intensive programme for educating their pupils on HIV transmission and preventive measures.

- iv. The study established that jobs in the oil sector are cyclic in nature and fluctuations in global oil prices affect exploration process and oil companies retrench their employees as it was the case in South Lokichar Basin in 2015. Business revenues too in Lokichar town declined. Many locals in the study area are abandoning their traditional sources of livelihoods to secure jobs in the oil companies and many investors are depending on the employees of the oil companies in their business. This problem can be solved by the county government and other related agencies developing a policy to implement a more holistic approach to create avenues that incorporate NGOs and other institutions in capacity building of locals especially regarding education, improvement of the traditional source of livelihoods. The capacity building approach will cushion the locals from the cyclic job opportunities in oil and gas exploration sector and frequent effects of plummeting global oil prices that may lead to their retrenchment even in oil production stage. The county government too must develop a policy to develop cottage industries to do value addition,

such as weaving and basketry, fishing, tannery, milk processing. This will cushion the locals in future against job loss and business opportunities .

5.4 Suggestions for Further Research

This study adopted exploratory mixed method research design and established that oil and gas exploration causes both biophysical effects and social-economic effects and effective constitutional, policy, legal and institutional framework will ensure sustainable environmental management in Oil Block 13T South Lokichar Basin, Turkana County. Nevertheless the findings of this study establishes the importance of further research into the topic of oil and gas exploration and sustainable environmental management. First an in-depth analysis of the probability of water, soil and air pollution from drilling waste materials needs to be carried out its relationship to the increasing respiratory, skin and eye diseases in the oil fields needs to be studied. Secondly, it would be beneficial to carry out a detailed research focusing on the analysis of the leadership, power and politics components and their influences on oil and gas exploration and production in Turkana County. Finally, a study on the effects of oil production on the environment needs to be carried out once large scale oil production commences in the study area

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APPENDICES

Appendix 7.1 Questionnaires and Interview Questions



KENYATTA UNIVERSITY
SCHOOL OF ENVIRONMENTAL STUDIES
DEPARTMENT OF ENVIRONMENTAL PLANNING AND MANAGEMENT, NAIROBI
KENYA

1. HOUSEHOLD QUESTIONNAIRE

My name is David Mugendi a PhD student from Kenyatta university .I am carrying out an academic research on the impact of oil and gas exploration on biophysical and social - economic environment in Turkana County. The main objective of the research is to come up with recommendations that would ensure sustainable environmental management. I kindly seek a few minutes of your precious time to help me get the needed information

1. Basic Data

HOUSEHOLD NO: Village..... DATE:

.....

1 ()	Interview is administered to the household head
2 ()	Interview is administered to a close family member

His or her relationship to household head

--

ii) Personal data

1. Name:
.....
2. village of origin.....
3. Ward.....
4. Contact:Mobile.....
5. Age.....
6. Education Level (specify the final class)
 - a. Primary: []
 - b. Secondary: []
 - c. College: []
 - d. University: []
7. Gender:
 - e. Male []
 - f. Female []
8. MaritalStatus:(tick appropriately)
 - a) Married []
 - b) Single []
 - c) Divorced []
 - d) Separated []
 - e) Widowed []
9. Occupation:
 - a) Civil servant []
Specify.....
 - b) Business lady/man []
Specify.....
 - c) Farmer []
Specify.....
 - d) Other []

(iii) HOUSEHOLD CHARACTERISTICS

Total number of household members

A1. Name	A2 Gender	A3 Age	A4. Relationship to Head	A5. Marital Status	A6. Is the family member literate or illiterate?	A7. What is the current/last school that the family member is attending/has graduated?
	1. Female 2. Male		1. Household Head 2. Wife/Husband 3. Son 4. Daughter 5. Son/daughter In-Law 6. Grandchild 7. Parent 8. Brother/Sister 9. Grandparent 10. Others (Specify) 999. I do not know	1. Single 2. Married 3. Divorced 4. Widowed 5. Separated 999. I do not know	1. Illiterate 2. Literate	1. Below school age Hasn't graduated from 2. any institution 3. Primary School Student 4. High School student 5. Vocational college. 6. University Student 7. University Graduate 8. Masters Student 9. Masters Graduate 10. Doctorate Student 11. Doctorate Graduate 999. I do not know

2.EFFECTS OF OIL AND GAS EXPLORATION ON SOCIO ASPECTS

A

i) Characteristics of Households- Migration

ii) How long have you been living here as a household/family?/Individual.....years

iii) Have you -as a household/Individual- ever lived in another place, such as another village, another town, and county .Where have you lived before?

1. Yes (state which county /district/village)..... 2. No

iv) Why did you move here? (Tick appropriately)

- 1 () Schooling of children
- 2 () search of work
- 3 () Escape war/ violence
- 4 () Escape drought/ famine
- 5 () other (specify)

v) Had any of your relatives/friends lived here before you came?

1. Yes 2. No

Was it easy to settle here or did you have trouble when you came? Please explain

B:How would you rate in a scale of 1-4, where 1=Adequate 2=Moderate, 3=Inadequate 4=Poor the establishment of the following social and physical infrastructures and service provision(a) before and (b) after the oil and gas exploration activities began (i) Hospitals (ii) Schools (iii) Roads (iv) Boreholes and water storage facilities (v) Security camps/police post

Social/Physical facility	Rating Before	Rating After
Hospitals		
Schools		
Roads		
Boreholes and water storage facilities		
Security camps/police post		

ii) On average, what distance do you cover to access water,health services and educational services since oil and gas exploration begun? (b) What is the waiting time before you get to a water resource?(Tick appropriately)

	Waiting time				Any Other	Distance covered to access;					Any Other
	0-1h	2-3h	4-5h	above5 h		1-3km	4-6km	7-9km	10-12km	above 13km	
Health											
Education											
Water											

iii) Name any new facility offering the above named services that may have resulted from the oil and gas exploration project.

New Facility	Name	Place located
Schools		
Health facilities		
Roads		
Police post/station		

iii) Kindly rate in a scale of 1-4 where 1=To a great extent, 2=Moderate extent, 3=Less extent, 4=Not at all, the extent to which you agree with the following statements on the effect of oil and gas exploration activities in Lokichar basin.(TICK appropriately)

Oil and gas exploration effects	1	2	3	4
Exploration results in displacement of settled communities from their community land Oil and gas exploration activities have led to the loss of the locals' livelihoods				
There has been public participation and engagement of the locals over oil and gas exploration issues such as land leasing, compensation, waste management and employment in Lokichar basin				
There has been consideration of gender equality for the job opportunities, tender services in the oil companies and engagement of women on decision making over oil exploration issues in South Lokichar basin(ASK MEN)				
There has been consideration of gender equality for the job opportunities, tender services in the oil companies and engagement of women on decision making over oil exploration issues in South Lokichar basin(ASK WOMEN)				

iv) How would you rate in a scale of 1=5, where 1= Very high, 2=High, 3=Moderate, 4=Low, 5=Rare the number of inter and trans boundary conflict cases experienced before and after commencement of oil and gas exploration?

Transboundary and inter-klan conflicts before					
Transboundary and inter-klan conflicts after					

Oil and Gas Exploration Effect on Economic aspect

What were/are the main income sources for your family?(Tick where appropriate)

Source	Before	✓ After
--------	--------	---------

Wage/salary		
Pastoralism		
Small scale farming		
Trade		
Rental income		
AID		
Any other Specify		

v) On average what was the range of your monthly income before the oil and gas exploration began and after?

Before

A 1000-30000.

B 31000-60000.

C 61000- 100000

.D above 100000

After

A 1000-30000.
60000.

B 31000-

C 61000- 100000.

D Above
100000

vi) To what extent has oil and gas exploration affected your economic status? Rate the extent in a scale of 1-4; where 1=Great extent 2=Moderate extent 3=Less extent 4=Poor,

(i) Great extent (ii) Moderate extent (iii) Less extent (iv) Poor

2. Oil and Gas Exploration Effects on Biophysical Environment

A. In your own opinion, among the following biophysical environmental issues which one do you think is the major problem that has resulted from oil and gas exploration activities?(Tick appropriately)

Poor disposal of drill waste materials	
Increased dust, light and temperatures pollution	
Noise pollution	
Littering of the compounds	
Clearance of vegetation	

2. KEY INFORMANTS INTERVIEWS GUIDING QUESTIONS

A: Local Chief/Deputy County Commissioners/ Interview Guiding Questions

1. On average how many land dispute and scarce natural resources inter-clan and transboundary related conflicts cases used to be reported in your office per year before oil and gas exploration begun and after oil and gas exploration begun?

2. What are other forms of conflicts that may have emerged with the commencement of oil and gas exploration and how many of such disputes are you experiencing on average per month/year?

3. What other challenges do you think may have resulted from the commencement of oil and gas exploration in Oil Block 13T South Lokichar Basin to the local communities?

4. What are some of the developments can you link to the new oil and gas exploration ventures in Oil Block 13T South Lokichar Basin?

B.NGO /TUPANDO/FOLT Interview Guiding Questions

1. How many conflict cases did you record per annum before oil and gas exploration begun and after?

2. How has oil and gas exploration affected the locals source of livelihoods?

C. Youth Leaders Interview Guiding Questions

1. Are the local youth being considered for the opportunities that have come with the oil and gas exploration ventures?

2. What are some of the challenges that are facing the local youths?

D.Focused Group Discussion/Pastoralist Association Leader/ Guiding questions

1. What major challenges has oil and gas exploration brought in Turkana South Sub county in general in regard to pastrolism,community land ownership ,cultural and traditions of the community?

2. Who authorises the leasing of the community land and is there adequate public participation from all the clans?

3. How is the compensation of the community land being done and is it adequately being carried out?

E.Oil Exploring Companies Officials Interview Guiding Questions

1. What are the various sources of water for your operations? (Technical director)

2. How are you managing dust, drilling waste materials?(Lead environmentalist)

3. How are you managing the well testing gas flaring process?(Technical director)

4. How many employees from the locality, regional level, national level and expatriate have you employed in your company? (Cooperate affairs)

5. How well is the company engaging the locals/public participation?(director of communication, company Liason officers)

6. How is compensation for the community land being carried out by the company?(in charge of communication)

7. How are tender services and contract awarded by the oil companies?(in charge of communication)

8. Are the existing legal, policy and institutional framework in Kenya supportive for the oil and gas exploration and sustainable environmental management to the company?(lead environmentalist)

9. How many Well pads have you constructed so far?(technical director)

10. How sustainable are job opportunities in the oil and gas exploration and production sector? (cooperate affairs)

11. What infrastructures need to be put in place to facilitate oil and gas exploration and production? (technical director)

12. How is oil and gas exploration carried out and what are the requirements for process facilitation? (technical director)
13. Has the company been monitoring soil, water and air resources in Oil Block 13T South Lokichar Basin since oil and gas exploration begun?(lead environmentalist)
14. How has the company been managing the encountered dry wells/how fast is restoration carried out?(lead environmentalist)
15. What are some of the environmental policies, legislations and conventions that guide you on the management of environment during oil and gas exploration and production process?(lead environmentalist)
16. Have you had any dispute with the locals over their land/environmental resources and how many of such conflicts and how were they resolved? (in charge communication)
17. How expansive is a well pad area size in hectares? (technical director)
18. How much of the Well pads access roads has the company constructed since 2012?(in charge of communication)
19. What are some cooperate social responsibility that the company has undertaken since 2012 in Lokichar Basin?(Cooperate affairs and Director of communications)
20. What form of agreement has the company signed with the Kenyan Government over sharing of proceeds from oil and gas exploration and development of the upstream petroleum segment?(in charge of communication)

F.County Environment Field Officer Interview Guiding Questions

1. How would you rate the oil companies management of their waste disposal, air,water and solid waste?
2. How would you rate the oil companies restoration of the dry wells?

G.Lokichar Ward MCA/CEC Environment Turkana County Interview Guiding Questions

1. As a County, what policies and regulations do you have in place to help you in ensuring socio-economic and biophysical environmental sustainability management for the wellbeing of the Turkana communities in the backdrop of oil and gas exploration?
2. What is the level of engagement of the County Government by the National Government, the oil exploring companies in licensing of the oil blocks, leasing of the community land for oil and gas exploration and the entire process of upstream petroleum segment?

H. National Museum Official Interview Guiding Questions

1. Is oil and gas exploration going to affect the archaeological sites and archaeology research?
2. Do we have an elaborate legislation guiding the management of historic and archaeological sites in Kenya?

I. NEMA Official Lodwar Interview Guiding Questions

1. How often is the agency doing the monitoring of water, air and soil resources for the ecosystems surrounding the oil and gas exploration sites?
2. Are there adequate legislations to regulate the upstream petroleum segment to ensure sustainable environmental management in Kenya?
3. Are there any challenges facing the agency?

J. WRA Official Lodwar Interview Guiding Questions

1. Is the agency able to regularly monitor the water resources, underground water, water pans and rivers for any contamination in areas around the oil and gas exploration sites?
2. Are there any challenges that are facing the agency?

Lokichar Ward Headteacher/teachers Interview Guiding Questions

1. What academic benefits can you attribute to the commencement of oil and gas exploration in this area?
2. What are some of the challenges would you point out that they have resulted from the commencement of oil and gas exploration in Oil Block 13T South Lokichar Basin?
3. What do you think should be done to ensure smooth learning of the students despite the new oil and gas exploration ventures?

K. Local Health Facilities Clinical Officers Guiding Questions

1. Do you think oil and gas exploration commencement may have exacerbated or triggered some medical conditions in Lokichar Basin?
2. What are some of the medical management challenges would you say you are facing since oil and gas exploration activities begun and how do you think they can be managed?

L. Religious Leaders

1. Has oil and gas exploration affected the moral ethics of the local communities in any way?

3. BUSINESS COMMUNITIES QUESTIONNAIRES

My name is..... ..David Mugendi a PhD student.. from Kenyatta University .I am carrying out an academic research on socio -economic ecosystem responses to oil and gas exploration in Turkana County in order to come up with recommendations towards sustainable socio –economic environmental management. I kindly seek a few minutes of your precious time to help me get the needed information

Name of the Business	Average amount of income per Month before 2012	Average amount of income per month before from 2013 to date
RETAIL SHOPS		
1.		

2.		
3.		
Guest houses		
4.		
5.		
6.		
Hotels		
7.		
8. ...		
Cybers business		
9.		
10.		
11.		

Appendix 7.2 PhD Substantive Registration



**KENYATTA UNIVERSITY
OFFICE OF THE REGISTRAR (ACADEMIC)
TEL: 8710901 EXT: 57184
Email: admissions@ku.ac.ke**

=====

Our Ref: N82/28621/2013

Date: 28th October, 2016

Kariuki David Mugendi,
P.O Box 66172 – 00800,
NAIROBI.


Dear Mr. Kariuki,

RE: SUBSTANTIVE REGISTRATION (PH.D)

Following the recommendation the Dean, Graduate School, you are hereby granted substantive Ph.D. registration.

Please note that your registration number and all rules and regulations remain the same as per your admission letter.

Thank you.


**J. I. O MICHOKI
FOR: REGISTRAR (ACADEMIC)**

c.c. Dean, Graduate School.
Dean, School of Environmental Studies.
Chairman, Dept. of Environmental Planning & Management

JIOM/ma.

Appendix 7.3: Approval of Research Proposal



KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke

Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 810901 Ext. 57530

Internal Memo

FROM: Dean, Graduate School

DATE: 25th October, 2016

TO: Mr. Kariuki David Mugendi
C/o Department of Environmental Planning & Management
Kenyatta University

REF: N85/28621/13

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

We acknowledge the receipt of your revised Research Proposal entitled "Oil Exploration and Sustainable Environmental Management in Turkana County, Kenya" as per recommendations raised by the Graduate School Board of 7th October, 2016.

You may now proceed with your Data collection, subject to clearance with the Director General, National Commission for Science, Technology & Innovation.

As you embark on your data collection, please note that you will be required to submit to Graduate School completed supervision Tracking Forms per semester. The form has been developed to replace the progress Report Forms. The Supervision Tracking Forms are available at the University's Website under Graduate School webpage downloads.

By copy of this letter, the registrar (Academic) is hereby requested to grant you Substantive registration for your Ph.D. studies.

Thank you

A handwritten signature in black ink, appearing to read 'Reuben Muriuki'.

REUBEN MURIUKI
FOR: DEAN, GRADUATE SCHOOL

c.c. Chairman, Department of Environmental Planning & Management

Registrar Academic – Att. J. Likani

Supervisor

1. Prof. Caleb Mireri
C/o Department of Env. Planning & Mngt.
Kenyatta University
2. Prof. K. Kibwage
School of Coop. & Community Development
The Cooperative University College of Kenya
C/o Department of Env. Planning & Mngt.
Kenyatta University

Appendix 7.4 Research Authorisation Letter



KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: kubps@yahoo.com
dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 8710901 Ext. 57530

Our Ref: N85/28621/13

Date: 25th October, 2016

The Director General,
National Commission for Science, Technology & Innovation
P.O. BOX 30623-00100
NAIROBI

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION FOR MR. KARIUKI D. MUGENDI REG. NO.N85/28621/13

I write to introduce Mr. Kariuki who is a Postgraduate Student of this University. He is registered for Ph.D. degree programme in the **Department of Environmental Planning & Management in the School of Environmental Studies.**

Mr. Kariuki intends to conduct research for Ph.D. Degree thesis entitled “**Oil Exploration and Sustainable Environmental Management in Turkana County, Kenya**”

Any assistance given will be highly appreciated.

Yours faithfully,

A handwritten signature in black ink, appearing to be 'Lucy N. MBAABU'.

MRS. LUCY N. MBAABU
FOR: DEAN, GRADUATE SCHOOL

RM/cao

Appendix 7.6: Research Budget

Budget Items	Quantity	Cost/Unit	Year 1 Amount (KES)	Year 2 Amount (KES)	Year 3 Amount (KES)
Expendable supplies					
Water Sample analysis For physical chemical parameters of 4 borehole samples and Laboratory chemicals cost for	36 samples	2000		72,000	
Commercial analysis of heavy metals in drill cuttings	15 samples	5000		75,000	
Topographical maps of Turkana county		18,000		18,000	
Shape files data for Turkana for the two sites(Buying and processing Landsat satellite images Images(2005-2018)	16	10,000 Ksh. (10km squared)		160,000	
Sub-total				438,000	
Air ticket to Lokichar from Nairobi			5 trips		
local transport from Lodwar to Lokichar, four wheel drive hire	3 weeks(21 days)	20,000		100,000	
accommodation	21 days	5000		105,000	
4 Local enumerators/Research assistant during data collection	21 days	5000		105,000	
Communications	21 days	4000 per day @ enumerator 1000		84,000	
		6000		6,000	
Sub-total					
Documentation, publication costs, conferences				400,000	
Questionnaires Printing	500@10 pages		5000.000		
Publications	3 papers	18000		54,000	
Conferences	6	20,000		80,000	20,000
Printing of draft, final thesis and binding	10 copies (200 pgs)	40,000		160,000	80,000
Sub-total		7000		30,000	40,000
Yearly Budget				420,000	140,000
Total Budget			1,298,000.00 ksh.		

Appendix 7.7 Study Time Schedule

DURATION	ACTIVITY
September 2015- December 2016	Proposal development, presentation and approvals/data collections tools development/pilot survey
January 2017-September 2017	Data collection and analysis
October 2017- December 2017	Drafting of the first thesis draft
January 2018	Submission of the first draft to the supervisors
February 2018	1 st Presentations of the findings at the EPM department
March 2018-June 2018	Working on comments and drafting of the 2 nd thesis draft and submission
September to October 2018	Working on comments from the 2 nd Draft and drafting the 3 rd thesis draft
November 2018	Submission of notice for submission to graduate school and 2 nd finding presentation
December 2018	Submission of the thesis for examination
April 2019	Defense at the graduate school
July-December 2019	corrections
July 2020	Graduation

Appendix 7.8 Drill Cuttings Sampling Sites and procedure



Appendix 7.9 :Focused Group Discussion



Appendix 7.10: Water Sample Analysis



Appendix 7.11: Report of Twiga 1 Area Soil Sample Analysis

6.1 Soil Results

Table 5: Soil analysis results summary as per report no. MA17-01878 & MA17-01879

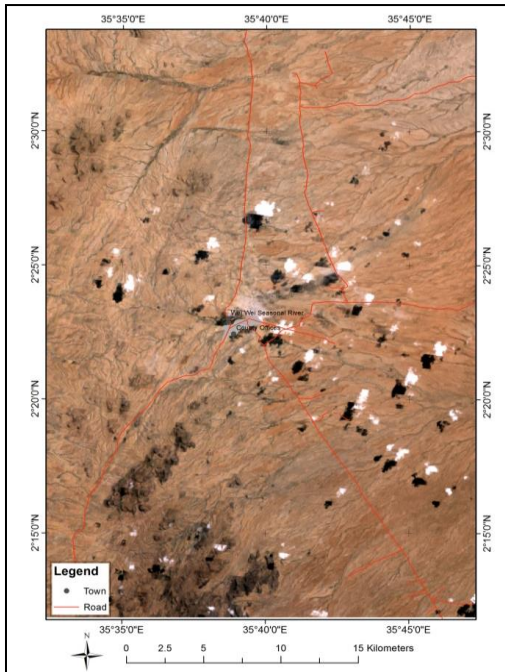
PARAMETER	UNITS	METHOD	D.I.V	RESULTS				
				SM 7	SM 8	SM 9	SM 10	SM 12
SAMPLING POINTS								
Benzene	mg/kg	SGS TW 44	151	<0.05	<0.05	<0.05	<0.05	<0.05
Toluene	mg/kg	SGS TW 44	32	<0.05	<0.05	<0.05	<0.05	<0.05
Ethyl benzene	mg/kg	SGS TW 44	110	<0.05	<0.05	<0.05	<0.05	<0.05
m- + p - Xylene	mg/kg	SGS TW 44		<0.05	<0.05	<0.05	<0.05	<0.05
O - Xylene	mg/kg	SGS TW 44		<0.05	<0.05	<0.05	<0.05	<0.05
Total Xylene	mg/kg	SGS TW 44	17	<0.05	<0.05	<0.05	<0.05	<0.05
TPH C5-C30	mg/kg	SGS TW 56	5000	-	-	-	-	-
Mercury	mg/kg	D/SGS TW 12	4	<0.005	<0.005	<0.005	<0.005	<0.005
Barium	mg/kg	EPA 3050 B	920	37.27	40.87	89.61	87.05	64.41
Chromium	mg/kg	EPA 3050 B	180	10.76	5.35	12.60	8.34	7.36
Copper	mg/kg	EPA 3050 B	190	4.39	5.56	13.33	7.81	9.09
Nickel	mg/kg	EPA 3050 B	100	6.08	4.11	9.06	5.68	5.14
Lead	mg/kg	EPA 3050 B	530	9.34	5.72	30.85	16.84	15.03
Zinc	mg/kg	EPA 3050 B	720	13.38	14.51	26.66	19.94	13.92

Appendix 7.11 Cont'

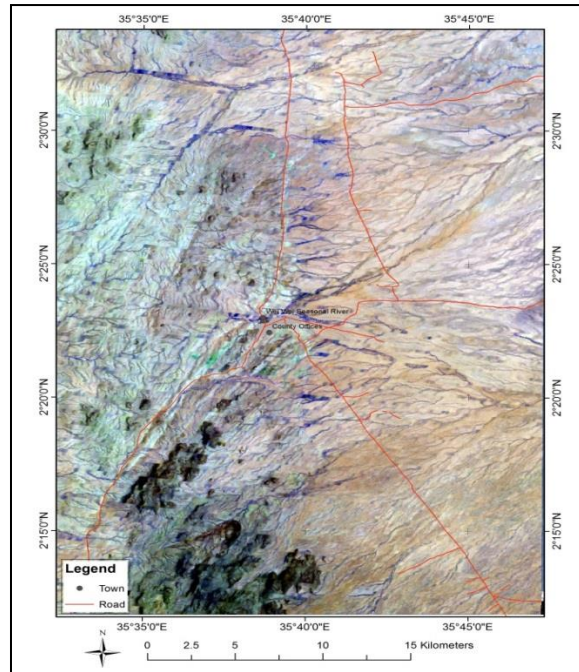
Table 6: Soil analysis results summary as per report no. MA17-01878 & MA17-01879

PARAMETER	UNIT	METHOD	D.I.V	RESULTS						
SAMPLING POINTS				SM 14	SM 15	SM 16	SM 17	SM 18	SM 19	SM 20
Benzene	mg/kg	SGS TW 44	1.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Toluene	mg/kg	SGS TW 44	32	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ethyl benzene	mg/kg	SGS TW 44	119	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
m- + p - Xylene	mg/kg	SGS TW 44		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
O - Xylene	mg/kg	SGS TW 44		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Xylene	mg/kg	SGS TW 44	17	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
TPH C5-C30	mg/kg	SGS TW 56	5000	1.12	27.86	109.14	2.32	65.40	49.84	28.91
Mercury	mg/kg	D/SGS TW 12	4	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Barium	mg/kg	EPA 3050 B	920	151.81	1735.92	3063.17	879.11	6744.39	5378.12	5366.84
Chromium	mg/kg	EPA 3050 B	180	8.42	10.96	10.73	12.70	14.91	18.18	14.63
Copper	mg/kg	EPA 3050 B	190	9.33	14.55	14.85	8.50	56.59	30.61	18.55
Nickel	mg/kg	EPA 3050 B	100	6.15	8.55	8.84	8.13	9.21	10.53	9.52
Lead	mg/kg	EPA 3050 B	530	<0.02	6.26	6.26	4.79	1768.03	352.46	13.66
Zinc	mg/kg	EPA 3050 B	720	16.26	24.08	27.36	16.09	148.46	57.31	28.58

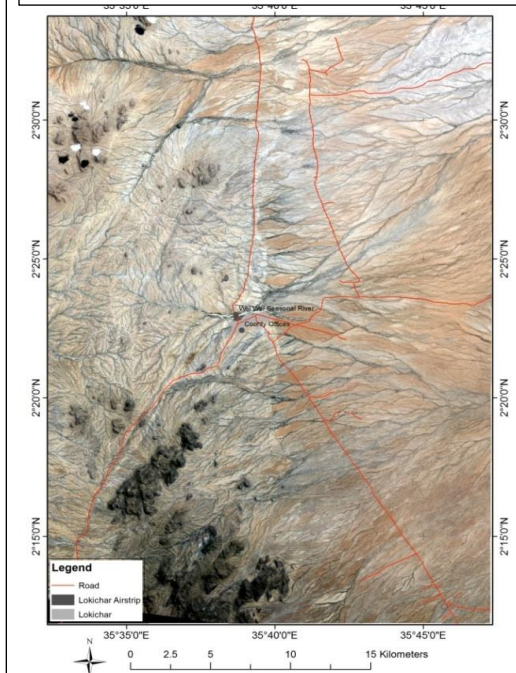
Appendix 7.12 :Landsat 5 and landsat 8 Satellite Images



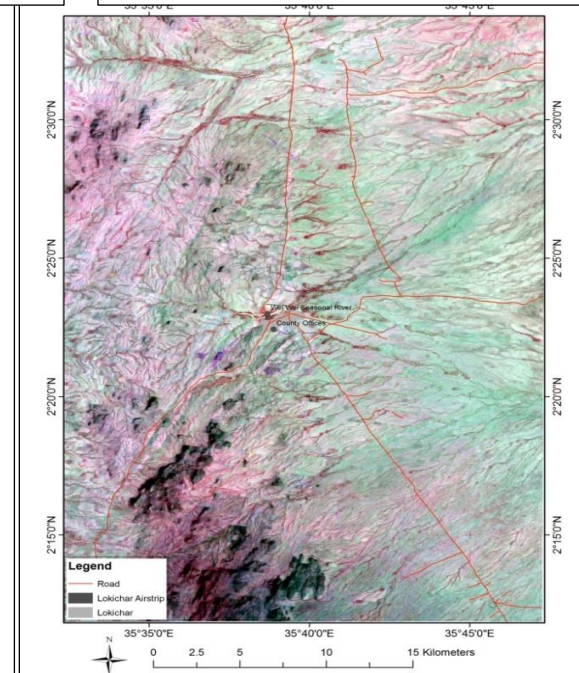
a1 Landsat 5 image dry season 2006



a2 Landsat 5 image rainy season

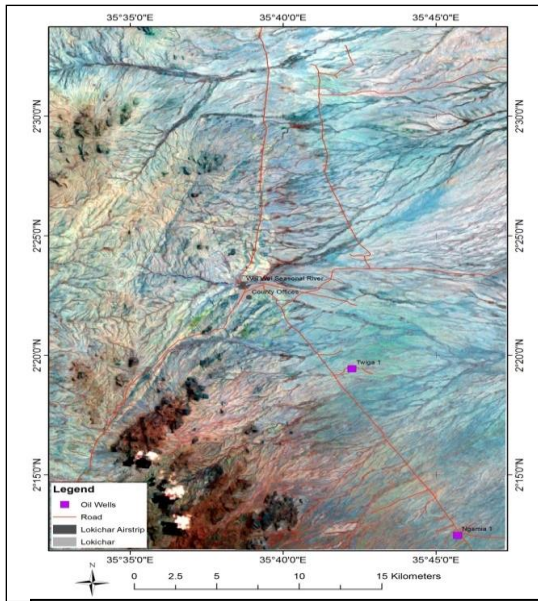


b1 Landsat 5 image dry season 2009

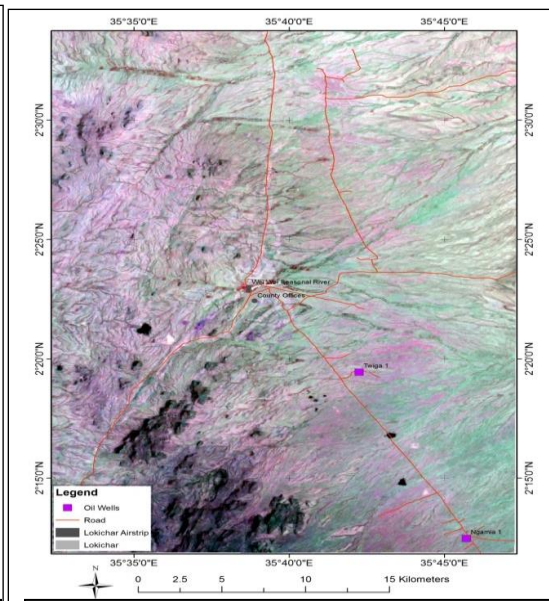


b2 Landsat 5 image rainy season 2008

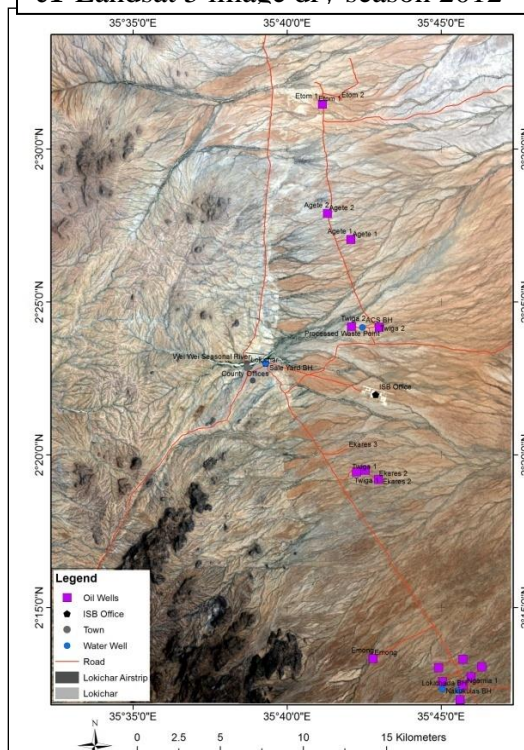
Appendix 7.12 Conti'



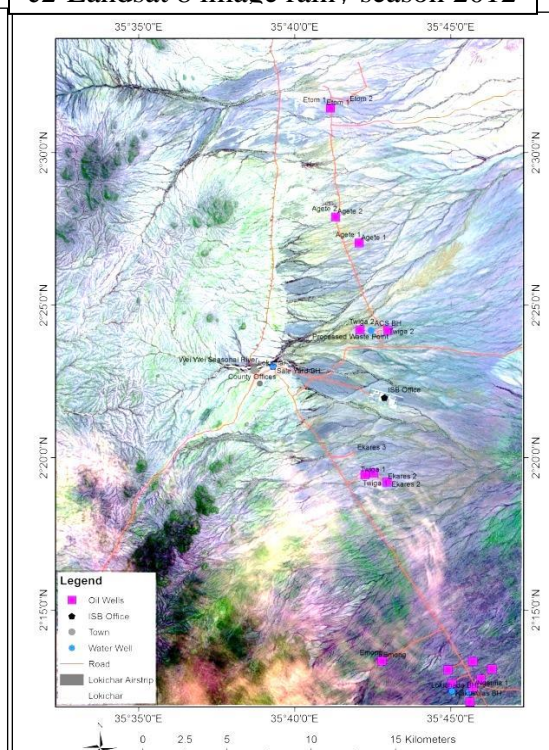
c1 Landsat 5 image dry season 2012



c2 Landsat 8 image rainy season 2012

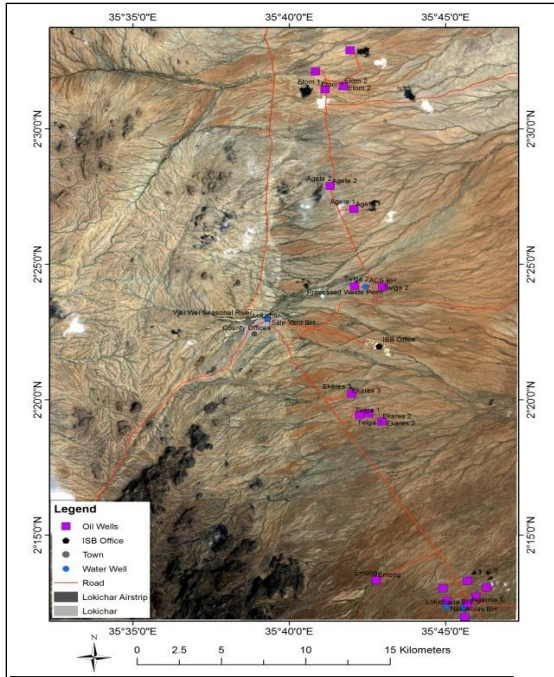


d1 Landsat 8 image dry season 2015

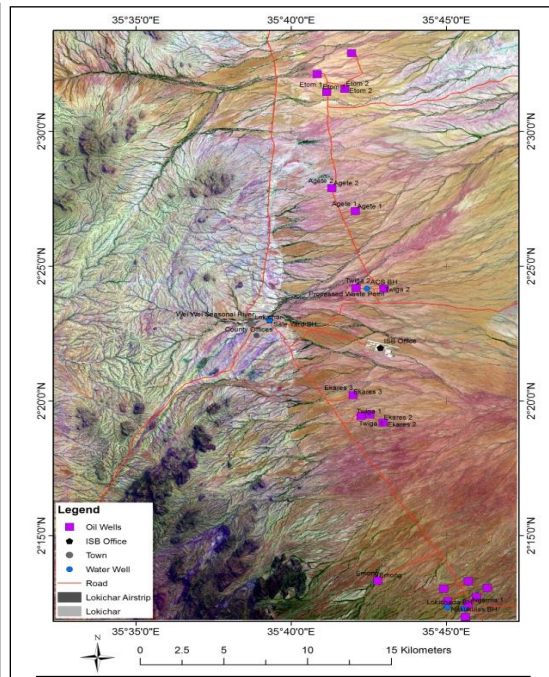


d2 Landsat 8 image dry season 2015

Appendix 7.12 Conti'



e1 Landsat 8 image dry season 2017



e2 Landsat 8 image rainy season

Appendix 7.13: Two Sample T test for the Land Cover

Two sample T-test for the forest cover

	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
x	3	14.35667	135.6877	235.0181	-569.4606	598.1739
y	2	-1574.767	433.7225	613.3762	-7085.734	3936.199
Combined	5	-621.293	419.3493	937.6935	-1785.593	543.0072
Diff		1589.12	454.4517		-2343.947	5522.195
diff = mean(x) - mean(y)					t = 3.4968	

Ho: diff = 0 Satterthwaite's degrees of freedom = 1.19958

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
 Pr(T < t) = 0.9282 Pr(|T| > |t|) = 0.1436 Pr(T > t) = **0.0718**
Sign at 1%

Two -sample T-test for the Grassland

	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
x	3	-5026.907	2263.44	3920.39	-14765.7	4711.888
y	2	1216.098	6857.692	9698.242	-85919.15	88351.34
Combined	5	-2529.705	2928.865	6549.1	-10661.54	5602.127
Diff		-6243.004	7221.572		-66590.73	54104.72
diff = mean(x) - mean(y)					t = -0.8645	

Ho: diff = 0 Satterthwaite's degrees of freedom = 1.22249

Ha: diff < 0 Ha: diff = 0 Ha: diff > 0 Pr(T < t) = 0.2619
 Pr(|T| > |t|) = 0.5238 Pr(T > t) = **0.07381** **Sign at 1%**

Two sample T-test for the Shrubland

	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
x	3	2083.693	2897.297	5018.266	-10382.37	14549.76
y	2	-5190.517	717.9575	1015.345	-14313.03	3931.997
Combined	5	-825.99	2396.80	5359.42	-7480.6	5828.618
Diff		7274.211	2984.928		-4352.191	18900.61

diff = mean(x) - mean(y) t = 2.437 Ho: diff = 0
 Satterthwaite's degrees of freedom = 2.2363

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0 Pr(T < t) = 0.9391
 Pr(|T| > |t|) = 0.1218 Pr(T > t) = **0.0609** **Sign at 1%**

Appendix 7.14: Water tanker used to refill the installed water storage tanks

