CHAPTER I

INTRODUCTION

1.1 Background:

Rangelands play a major role in supplying the human population with animal products in the entire land region in the world. Rangelands account for 16% of world food production compared to 77% for cropland (Holechek, *et al* 2004). Developing countries with rapidly increasing human population, such as Sudan, have experienced large-scale increases in range livestock number; it's expected in next 25 years to increase further more, and more herders share a declining land base due to conversion of rangeland to crop lands.

In Sudan over a thousand years, grazing has been one of the major land use activities and continues to remain an important activity. Often grazing has been poorly managed and has led to a large- scale soil loss. Currently, many rangelands show signs of either degradation or overgrazing; both conditions lead to reduced vegetation cover and water absorption in the soil. This, in turn, leads to accelerated rangeland environmental degradation (FAO, 2005).

Natural vegetation is one of the most important environmental balancing factors in arid and semi-arid areas. Over the last three decades, this cover has been affected by successive periods of drought and desertification, traditional and agricultural rain fed expansion, overgrazing, overhunting, seasonal fires, unregulated expansion of water resources and exploration and mining leading to sand creep southward into the savannah, (RPGD,2015).

Sudan defined gold in ancient times and called the northern part of it the land of Nubia meaning the land of gold has been extracted gold since the Pharaonic and Turkish. In Sudan, mining started with the beginning of geological work in 1905 through the Government Geological Office. The office was developed into a geological survey unit in 1939 and developed into a geological survey in 1953. During the period from 1905 to 1956, geological work focused on the search for groundwater only, (https://photius.com/countries/sudan/economy/sudan_economy_mining.htm). This stage followed another phase which extended from 1956 to 1990, where the number of geologists and geological work increased the stages of geological surveys to explore minerals and the search for groundwater and exploration. (https://photius.com/countries/sudan/economy/sudan_economy_mining.htm).

Geophysical studies and surveys have demonstrated the presence of arcane markers containing gold and metal in different parts of the country.

These factors affected the components of the ecosystem, which have had a negative impact on natural resources, including the pasture resource, (RPGD,2015).

1.2 Problem Statement and Justification:

During the recent periods, the natural rangeland in Sudan has been subjected to successive negative impacts, which have been reflected in its qualitative and quantitative characteristics. Al-Sobag area in Gedarif State is among the most affected areas by the artisanal gold mining process that practices by people are widespread in vast areas, and the domination of rain fed mechanized agricultural schemes. These factors lead to changes in vegetation cover, soil degradation, and deterioration of the rangeland environment particularly in Al-Sobag area. Moreover, the lack of information, document about the impacts of the mining process on rangeland degradation and socio- economic problem that faces the pastoralists in the area, such as conflict between different land users.

1.3 Objectives:

1.3.1 General objective:

Assessment the impacts of artisanal gold mining on vegetation cover of natural rangeland components and socio-economic aspects of local communities in Al-Sobag area – Gedarif state.

1.3.2 Specific objectives

1- To assess the impacts of artisanal gold mining on rangeland vegetation attributes in Al-Sobag area.

2- To assess the impacts of artisanal gold mining on soil seed bank on Al-Sobag area

3- To assess the awareness of local communities about the impacts of artisanal gold mining on their livelihoods in Al-Sobag locality**.**

4- To find the suitable solution to this impacts in order to promote sustainable management of natural rangeland

1.4 Hypotheses:

- The artisanal gold mining has negative impacts in vegetation cover and deterioration of range ecosystem in the Al-Sobag area.

- Misuse of rangeland leads to change in the botanical composition of high-value grazing plants species.

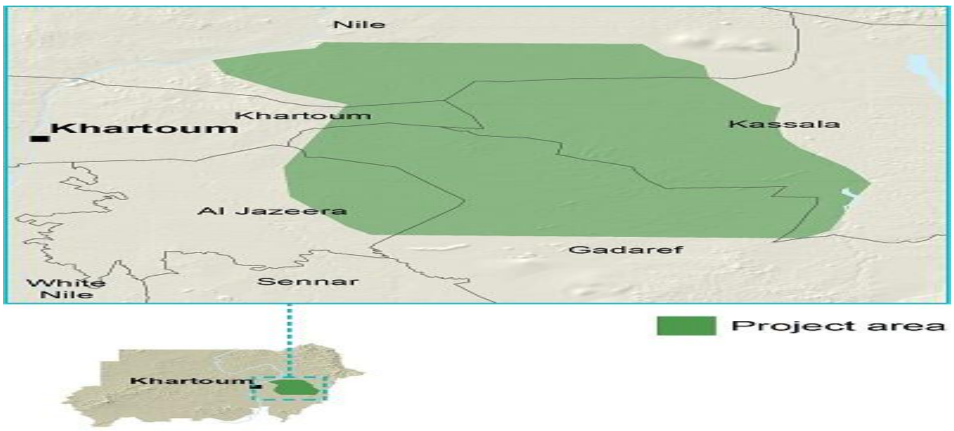
- The artisanal gold mining operations affected the soil seed banks on Rangeland in the Al-Sobag area.

- The socio-economic aspects of local communities have affected by the artisanal gold mining in the Al-Sobag area.

1.5 Study Area

1.5.1 Location:

This study was conducted on Gedarif state in eastern Sudan in Butana localities Al-Sobag area. Internally Gedarif is bordered by four states, namely Kassala state to the north, River Nile state to the northwest, Gezira state to the west and Sennar state to the south. Butana is one of seven localities that all combined forming Gedarif state. These are Fashaga, Faw, Gallabbat East, Gallabbat West, Gedarif, Rahad and Butana locality (Mahalyat El Butana). Geographically, Butana is located between latitude (13 º N up to 16 º N) and longitude (34 º E to 37 º E) within an area of 34000 km ², with 48 villages and 4 parties (Hai). (El Hadary, 2010).



Map (1) Butana area

*https://www.ifad.org - Butana Integrated Rural Development Project

1.5.2 Population:

At 2008, the total population of Gedarif has reached 1 348 378 inhabitants with 78000 in Butana, (CBS, 2010), being composed of people belonging to several ethnic groups including Arabs and non- Arabs tribes.

1.5.3 Climate:

Ecologically, Butana lies within the semi-arid region, where annual rainfall ranges between 75 in the far north to 400 mm in the south (Elhadary, 2010).

(Abusin, 1970) reported that the temperature in Butana is considered to be high all the year round. The area is characterized by a short wet season in mid-summer and a long dry season throughout the rest of the year. The open nature of the area and free movement of the air accelerate evaporation. The mean relative humidity varies from a minimum of 25% in April to a maximum of 65%, 74% and 72% during the rainy season (June, August and September), respectively.

1.5.4 Geology:

Andrew (1984) and Delany (1955) classified Butana as basement complex in the middle and to the south east; Nubian formation in the west and south the central region is a basement complex with flat surface; with only a few rocky hills breaking the monotony of the plain. The central part is clay plain with numerous water courses (El-Hassan, 1981).

1.5.5 Soils:

T1he topsoil is mid-brown, grey friable clay with round quartz pebbles and stone fragments. The cracks are not wide, but medium in size and are more abundant in the soil under the grass. The soil is a medium to fine textured light clay, sandy clay or salty clay which contains more than 40% expanding clay (HTS1966, Khalil, 1986). The soils of area can be classified into main types: Vertosole, Antisole, Versole and Rocky soil (Alsafi, 2009).

1.5.6 Vegetation:

The occurrence and distribution of vegetation in the study area are generally determined by amount and distribution of the rainfall, as well as topography also soil texture play an important role in a detailed description of the distribution within areas receiving the similar amounts of the rainfall((Abusin, 1970)). There are three main types of the natural vegetation in the Butana. The Acacia trees that form the major perennial type, including *Acacia tortilus*, *Acacia seyal* and *Acacia mellifera*. The shrubs are the second perennial type of vegetation, including bushy grasses scattered all over the region. The third type includes the annual grasses and herbs. Grasses include *Schoenefeldia gracilis* (Gabash), *Sorghum purpureosericeum* (Adar), while herbs include *Ipemea cardiosepala* (Hantut), *Ipomea cordofana* (Taber) and *Blepharis edulis* (Siha).These herbaceous plants are dominant during the wet season, but after the rainy season they wither and disappear and only a few species can be seen during the dry season. The climax vegetation in the Butana, is *Blepharis edulis* (Siha) (Harrison, 1955), where herbs were abundant and often occupied large areas as pure stands.

1.5.7 Water Resources:

There are five main water sources in the Butana plains; the river Nile and Blue Nile (including irrigation canals in Halfa and Rahad schemes) River Atbara, the seasonal Wadis and khors, boreholes and hand-dug wells, and hand-dug and machine-dug Hafirs. Hand-dug wells represent another semi-permanent source of water. The most suitable sites for these wells are seepage areas and shallow sub-surface water tables in or close to Wadis, where most of the shallow wells are found. Other good sites are the joints and depressions. However, a number of wells have been abandoned because their water proved unhealthy for human and/or animal use, Abusin (1970).

Natural and man-made reservoirs are another major source of water in the area. Natural depressions (*Mayaat*) tend to hold seasonal running water for a relatively long time due to the nature of the dark clay soil. Shallow wells or (*Jammamas*) are also dug within or in the vicinity of these depressions and represent a major water source during the dry season. Man-made reservoirs or *Hafirs* serve the same functions. In the past the location and size of these reservoirs used to determine the mobility pattern of the nomadic herds in the area, (Fadlalla and Ahmed, 2006).

1.5.8 Land Tenure and Land Use:

Butana lands are officially owned by the government of Sudan. The government, however, recognition of usufruct rights of wood cutting and animal grazing for residents. Nevertheless, some of the early residents of Butana, have by one way or another claimed the ownership of agriculture] lands irrigated by the seasonal Wadis. These groups have maintained a claim of land ownership through continuous use for successive years. Three main forms of relationships between land users and owners exist:

1. (*El Dogondi*), a cash payment by the beneficiary to the land owner who decides the amount.
2. (*Awayed*) which is similar to (El Dogondi) but the payment is left to the beneficiary to decide on the amount
3. (*Okul-Goom*) (Literally meaning eat and leave). This is a right of cultivation given by land owners to users for no rent. It applies for one season, after which the user is expected to leave the land.

Subsistence agriculture generally prevails. In (*Bildat*) and (Turus) cultivation, land holdings are small, ranging between 5 and 10 feddans, but in the Wadi land, plots are much larger. The main crop grown is sorghum and the dominant varieties are Feterita and Mugud which are claimed to store well in Matmuras (an excavated pit in the ground for storage of sorghum) (Bailey *et at.* 1996).

1.5.9 Human Activities and Livestock Rising:

Over 70% of the Butana populations depend on livestock for their livelihood under nomadic and semi-nomadic systems. While livestock rising was the center of the economy for nomads, for the settled communities it were a secondary, yet very important activity for maintaining subsistence. The camel was the most important animal raised mainly as means of adaptation to the Butana environment. Sheep came second in the importance follow by cattle and then goats. Two main seasonal movements were practiced by livestock owners; one is the (*Nishug* and *Damar*), (Abusin 1970).

CHAPTER II

LITERATURE REVIEW

2.1 General:

Rangeland is the "land on which the native vegetation, predominantly grasses, grass-like plants, forbs, or shrubs suitable for grazing or browsing using it. Includes lands re-vegetated naturally or artificially to provide a forage cover that is managed like native vegetation, (SRM, 1974). The rangeland ecosystem differs from a natural ecosystem in that it will be purposely manipulated for more effective production of salable produce. It differs from the domestic crop ecosystem in that the total standing crop does not represent the exported product. The structure of the ecosystem is concerned with the whole community complex of plant composition, plant aggregation, life forms, layering, density, crown cover, leaf form, age classes, herbage yield, constancy, fidelity, etc.). The functioning of the ecological system is dependent on complex interrelationship between people, animal life, plants and the physical environment (Oba and Lusigi, 1987), which constitute a major renewable resource in a highly vulnerable, diverse and difficult environment, were most affected by such change. Rangelands in the semi-arid regions of the world that is too dry for reliable crop cultivation and hence used for livestock production of one form or another. They span the tropics and temperate zones, varying considerably in their vegetation and native fauna. Depending on the kind of rangeland, the welfare of the pastoralists who live in them is based on grazing animals (cattle and sheep), mixed feeders (browsers and grazers like camels and goats) or a combination of both (Walker and Janssen, 2002). Forages from common rangelands provide the vast majority of feed inputs in these systems. Across much of sub-Saharan Africa, extensive and semi-extensive livestock systems are based on the use of common-pool rangelands for the essential input of forage into livestock production (Winnie *et al*, 1998).. The quality of range forage varies with plant species, season, location, and range improvement practices (George, 1999**)**. The resilience of dry land vegetation is an outcome of the marked fluctuations between wet and dry seasons. Whereas growing vegetation is vulnerable to damage by grazing and trampling, dry-season vegetation is far below demand and has its own, defensive mechanisms such as protecting the living parts behind thorns or in the seeds (Behnke, 1993). Drought on rangelands reduces forage production and water supplies, placing serious pressure on the livestock industry (Oba and Lusigi, 1987). One-year droughts are more frequent than multi-year droughts. The occurrence of drought is more frequent in the arid areas than in the semi-arid zones (Sidahmed, 2001).

The total area of Sudan, which is covered by natural range, constitutes approximately 68.6 million hectares; this represented 35.6% of the total area (FAO, 2012). Sudan livestock population estimated as 108 million heads (MAR, 2017), more than 90% of this livestock depending on natural range as an essential source for feeding (Darag *et al*, 1995).

2.2 Socioeconomic Importance of Rangeland:

The rangeland provides one of the most important resources of the world's arid and semi-arid areas. 3.5 billion hectares of the earth's land are now pasture or rangeland. This area is 26% of the total and it's over 70% when we refer to agricultural land (Pardini *et al*, 2003). The total digestible nutrients produced by the world's rangelands could be measured in grain crop equivalents, the results would be outstanding (Norris, 1972). These are the region's rangelands which provide ninety or more percent of the food consumed by millions of head of cattle, sheep, goats, and wildlife (WRI and IIED, 1990). Semi-arid and arid rangeland systems are found in many parts of the world. They are ecologically very sensitive systems, yet they are of great local economic importance (Oba and Lusigi, 1987). The situation in the Near East and North Africa region most of the land area in the region (62%) is classified as rangelands (FAO, 1991). Sudan is the first among Arab countries, according to the number of livestock contributing, with 12% from the total production, and 50% of agricultural production (Darag *et al*, 1995).

Mobile pastoralism is an adaptive response to an inhospitable arid environment. Nomadic pastoralism postdates either agriculture or domestication of animals. It is a highly specialized form of land use, which arose in the steppe regions of the Old World and has continued there until the present (NGO, 2002). Pastoral nomadism is adapted to variable forage supplies and water distribution. The ability of nomadic people to survive in these marginal lands is attributed to their opportunistic mobility and diversified livestock husbandry (Oba and Lusigi, 1987). Africa contains a substantial portion of the world's arid and semi-arid rangeland, extending over three million square kilometers. These arid zones support an estimated 16-22 million pastoral population (Widstrand, 1975) and nearly 500 million head of livestock (FAO, 1975). There is much argument in favor of optimism with regard to the future of the rangelands in the arid/semi-arid areas (Sidahmed, 2001).

2.3 Rangeland Ecosystem Goods and Services:

Ecosystem services divided into four categories: provisioning, regulating, cultural, and supporting services. Among these, provisioning of forage for livestock is an important and a traditional service provided globally by rangelands. (MEA, 2005)

Rangeland ecosystem goods are tangible outputs from ecosystems, made available to humans through human activities, beginning with the extraction. Food and fiber are common examples of rangeland goods. Social and economic processes needed for extraction and subsequent processing and use of rangeland ecosystem goods are structured by our legal, institutional, and economic frameworks, particularly those affecting markets for such goods and the products to which they contribute. Tangible services are direct interactions with ecosystems that occur in situ, e.g., breathing air or being exposed to air temperatures or wind. Intangible services yield value to humans through experiences that are primarily perceptual, such as visual or kinesthetic experiences, rather than organic, such as eating or breathing. Viewing a scenic landscape would be an example of an intangible service. (Maczko and Hidinger, 2008**).**

2.3.1 Livestock Production:

The number of cattle, sheep, and goats increased by globally over 601 million individuals from 1979 to 2009, representing an addition of 1.6 million livestock animals per month over 30 years (Estell *et al*. 2012). Rangelands also provide important habitat for domestic livestock, including cattle, sheep, goats, and horses. Most of the world's livestock lives on rangelands and serve as a highly significant and necessary source of food and livelihood for people all over the globe. Ranching is an important endeavor that uses livestock to convert the nutritious and renewable grasses and other plants on rangelands into food, fiber, and other animal-based products for humans, **(**Havstad *et al*. 2007**).**

2.3.2 Wildlife Habitat:

A diversity of wildlife thrives on rangeland habitats. Mammals, birds, amphibians, reptiles, fishes, and even insects make their home in these complex ecosystems. Plants, water, and soils on rangelands provide unique environments for wild animals and plants, including threatened and endangered species. Some rangelands are designated as special protection areas for wildlife (Suleiman,1986).

2.3.3 Recreation:

Cultural services in rangelands are related to human experiences associated with activities such as wild game hunting, traditional lifestyles, and tourist ranching experiences. The demand for cultural services changes according to the region analyzed (Tallis *et al*, 2011) and has changed over time. The varied topography, scenic landscapes, and vast openness of rangelands are valuable to lots of people for recreation and tourism activities, (Moonen and Barberi, 2008).

2.3.4 Mining:

Rangelands are used for hard rock mining, such as gold, copper, silver, or zinc, which benefits the economy of surrounding communities. Water coming from rangelands generates hydroelectric power. Mining and extraction of coal, oil, and natural gas are important energy resources gained from rangelands**. (**Mosley,1985**).**

2.3.5 Biodiversity:

The relationship between biodiversity and ecosystem services has a long history in ecology. Recent discussion has been spurred by the possibility that loss of biodiversity negatively impacts other ecosystem services, such as nutrient and water retention (Liebman *et al*., 2013). Loss of biodiversity may affect ecosystem services based on the functional traits of species that are lost (Havstad *et al*., 2007).

2.3.6 Carbon sequestration:

Increasing atmospheric CO_2 concentrations for rangeland lead to increased Net Primary Productivity (NPP) of many plant species (Izaurralde *et al.*, 2011).Rangelands have the capacity to regulate levels of atmospheric CO_2 by sequestering carbon in the above and below-ground biomass of plants and in soil organic matter. However, the degradation of rangelands through soil erosion could lead to the release of stored carbon (Havstad *et al.,* 2007). At local scales, the potential of the soil to sequester carbon can be increased by converting cropland to rangeland, restoring degraded rangelands, and adopting better management practices to increase sequestration (Joyce *et al.,* 2013).

2.4 Rangeland Degradation:

Rangeland degradation is a decrease in plant species diversity, plant height, vegetation cover and plant productivity. Recently, degradation has also come to mean deterioration in ecosystem services and functions. In general, rangeland degradation is a reduction in the rank or status of natural vegetation. **(**Oba and Kotile, 2001**).**

2.5 Major Causes of Rangeland Degradation:

Rangeland degradation, a worldwide problem, loss of perennial grass cover and increase in annuals, unpalatable forbs and bush cover are the leading cause and also conversion of rangeland to cropland, wood harvesting and over-grazing by livestock are the major causes **(**Musa *et al.,* 2016**).**

2.5.1 Climate Change:

Climate change is seen as a key ecological driver that influences the dynamics of sub-Saharan rangelands (Hoffman and Vogel, 2008). As understand from different projected data that rangelands will be more negatively affected by climate change, with implications such as changes in water resources, rangeland productivity, land use systems and rangeland-based livelihoods. Anproblem that affects many sectors, including biodiversity (flora and fauna), agriculture, human health and water. Climate change may also increase the spread of invasive species (McCulley, *et al*, 2004).

2.5.2 Over-grazing:

Overgrazing of rangelands is a problem worldwide. According to the World Resource Institute **(**WRI, 1992**),** overgrazing is the most pervasive cause of soil degradation. In arid and semi-arid regions in Africa and Australia, overgrazing causes 49 and 80 percent for soil degradation respectively. In overgrazed land, the animals clip the vegetation to the bare ground, causing starvation and death of the root system **(**Purdon and Andreson, 1980**).**

2.5.3 Bush Encroachment:

Bush encroachment refers to the spread of plant species into an area where previously it did not occur. Invasion on the other hand, refers to the introduction and spread of an exotic plant species into an area where previously did not occur. In the process of bush encroached, land vegetation was shifting from herbage to bush, the coverage of herbage decreased and the area of bare land increased the spatial and temporal variability of soil water and nutrients were increased and the process has an important impact to the structure and function of the community ecosystem, which reduced herbage production, declined carrying capacity of native pasture, threaten sustainable progress of livestock production **(**Zhang *et al* ,.2001**).**

2.5.4 Drought:

The frequent drought in many parts of the Africa's lowlands is a prominent factor which has contributed to range degradation. When there is drought and overgrazing together, the effect on the productivity of the rangeland is double barreled (Herlocker, 1993). Prolonged drought, including a shortage and erratic rainfall can cause serious range degradation (Abate and Angassa, 2016). As a result, mobility is the most important pastoralist adaptation to spatial and temporal variations in rainfall, and in drought years, many communities make use of fall-back grazing areas unused in ‘normal’ dry seasons because of distance, land tenure constraints, animal disease problems or conflict (Blench and Florian 1999).

2.5.5 Human and Livestock Population Pressure:

An increase in the size of the population and overstocking are in turn causing imbalances, for example. The effects of overpopulation highly influenced on food availability and increased poverty have contributed to the sedentarization of pastoralists (Alemayehu, 2005). This makes most of the community concentrated one centered area on permanent water supplies (Herlocker, 1993 and Alemayehu, 2005) becomes overuse of rangeland resources and subsequently resulted in rangeland degradation and reduced biodiversity.

2.5.6 Traditional Rangeland Management Practice:

The recognition given by policy makers, leaders, researchers and development workers for indigenous knowledge and elders is still low (Abule and Alemayehu, 2015). Traditionally the communities used herd diversification, mobility and free ranging of communal land in order to protect rangelands from degradation (Oba and Kotile, 2001).

2.6 Rangeland Ecosystems Degradation:

The major indicators of rangeland degradation are shifting in species composition, loss of range biodiversity, reduction in biomass production, less plant cover, low small ruminant productivity, and soil erosion. The major indicators of rangeland degradation are shifting in species composition, loss of range biodiversity, reduction in biomass production, less plant cover, low small ruminant productivity, and soil erosion. Major changes in rangeland surface morphology and soil characteristics have a drastic effect on the primary productivity of the rangeland ecosystem, and in turn on livestock production (Payton *et al.*, 1992). There are a number of factors responsible for degradation; among others, are climate, grazing (Arnalds and Barkarson, 2003), soil quality, and landform and its influence on rangeland ecosystem hydrology (Garcia-Aguirre *et al.*, 2007).Identification of putative abiotic and biotic barriers to the natural regeneration of more desirable vegetation can lead to the implementation of appropriate restoration treatments (Whisenant, 1999).

2.7 Impacts of Rangeland Degradation:

Rangeland degradation has a great impact in the pastoral communities and in the country level that resulted in substantial declines in rangeland condition, water potential, soil status, and animal performance, livestock holding at the household level, while communities in general have lost their livestock asset and become destitute. And this Couse food insecurity for the local community and become a burden for the government due to the need for alternative livelihood income and diversification (Teshome and Ayana, 2016).In the long run it results poverty and tribal conflicts over grazing land and water resources (Solomon *et al*., 2007).

2.8 Rangeland Ecosystems Restoration:

The potential for ecosystem restoration can be optimized if the functional status of ecosystems is defined beforehand and the relationship between ecosystem structure and functioning can be established (Cortina *et al*., 2006). Local communities and other stakeholders such as policy makers and researchers must play an important part in the process if sustainable rehabilitation is to be achieved (Everson *et al*., 2007). Community based natural resource management (CBNRM) is regarded as the best approach to encourage better resource management with the full participation of resource users in decision-making activities and the incorporation of local institutions, customary practices and knowledge systems in the management process, (Armitage, 2005).

Kavana *et al.* (2005) suggest that there should be complementarities of modern scientific knowledge and traditional natural resource management for sustainable livestock productivity, biodiversity, and soil conservation in traditional agricultural systems. A scientific view might promote restoration goals derived from geomorphological and ecological imperatives (Kondolf, 1998). However, restoration is more of a process of modifying the biophysical environment and captures the interaction between scientific definitions and the goals of society as a whole (McDonald *et al.,* 2004).

The international community has long realized the need to protect the global environment and has negotiated numerous agreements over the years in an effort to encourage countries to address problems facing the environment. The good intentions of the parties in negotiating the multilateral environmental agreements (MEA‟s), most, if not all of them, especially in the developing world, lack the required capacity to implement such agreements (Bailey *et al,* 1996).

2.9 Range Condition and Trend:

2.9.1 Range Condition

Range condition is the state of health and vigor of a rangeland in relation to its full, productive potential (Heady, 1998). It describes an evaluation of the current status of rangeland vegetation (Manske, 2004), knowledge of range condition is the starting point for decisions regarding site evaluation in monitoring vegetation and soil conditions which are essential elements of good range management. It measures the degree of range deterioration and improvement. The initial and critical step in evaluating a range condition is to classify range sites in order to determine site potentials (Frost and Smith, 1991). Range condition is used as a guide to ensure sustainable land use; to determine carrying capacity for stocking rate adjustment; to identify potential responses to range improvement programs, and to evaluate the best locations for fencing and watering facilities to improve utilization within a range land (Tueller, 1991).

2.9.2 Range Trend:

Range trend assessments depend upon an evaluation of the general health of individual plants, the vegetation and the soil (Heady, 1998). According to Kefa and Oche, (1989) and Heady, (1998), the major attributes that need to be monitored and inventoried to determine the condition of rangelands are vegetation cover, frequency, density or abundance, herbage yield and species composition, Parameters in herbaceous layer survey includes cover, density and frequency. Water availability is another factor that needs to be assessed as it influences the presence of animals in rangelands and undoubtedly affects the distribution and promotion of the survival and production.

2.10 Patterns of Common Rangeland Utilization:

2.10.1 General:

Utilization is the proportion of a year’s forage production that is consumed or destroyed by grazing animals. Many arid and semi-arid rangelands have a large livestock population. Pastoralists are people who depend for their living primarily on livestock. They inhabit those parts of the world where the potential for crop cultivation is limited due to lack of rainfall, many pastoralists are nomadic or semi-nomadic. An important characteristic of pastoralists is their close relationship with their animals (SCBD, 2010)

2.10.2 Types of Rangeland Users:

- **Nomads:**

Pastoral nomadism, the major land use of the region, is adapted to variable forage supplies and water distribution. The ability of nomadic people to survive in these marginal lands is attributed to their opportunistic mobility and diversified livestock husbandry (Oba and Lusigi, 1987). Exclusive pastoralists are livestock producers who grow no crops and simply depend on the sale or exchange of animals and their products to obtain foodstuffs. This type of nomadism reflects almost directly the availability of forage resources; the more patchy these are, the more likely an individual herder is to move in an irregular pattern (Blench, 2001).

- **Semi Nomads:**

Semi nomadic system implies that stock owners have permanent place or semi-permanent place or residence, usually near to land on which his family may cultivate crops, but the travel with the herds for long periods away from their settlement, (Humphreys, 1991).

- **Sedentary:**

This type cultivates sufficient areas to feed their families from their own crop production. The key interaction between the sedentary and mobile communities that they often act as brokers in establishing cattle-tracks, negotiating the 'camping' of herds on farms, which potentially exchanges, crop residues for valuable manure, and arranging for the rearing of work animals which adds value to overall agricultural production (Blench, 2001).

2.11 Traditional Strategy for Common Rangeland Utilization:

The rangeland-dominating arid and semi-arid areas provided primary products (grasses, legumes and shrubs) which were converted into animal protein. In fact, continued utilization of the world's arid lands very much depends on viable pastoral systems (LIFE, 2001). Pastoral groups use a wide range of techniques in managing their natural resources, and that these systems are neither random nor irrational, but quite deliberate and adapted to the vagaries of their environment (Oba and Lusigi, 1987). The pastoral strategy is to use a broad array of species (cattle, camels, sheep and goats) which utilize different parts of the forage and have varying resistances to drought. In such a multi-product setting, where a pastoralist operates different livestock production systems, a decision must be made as to the stocking rates for each type of system (Lusigi and Buursink, 1994**)**. While camels and goats rely mainly on browse (Le Houerou, 1980). Two aspects of mobility should be recognized. Resource exploitation mobility is undertaken in response to unpredictable forage and water availability. The number of movements undertaken during any year depends on environmental conditions, the state of available resources, and the livestock species being managed (Oba and Lusigi, 1987).

2.12 The Importance of Gold Mining in the World:

It is estimated that over 100 million people in the majority world base their livelihoods on such mining. Bountiful mineral resources in certain rural locations, usually combined with the lack of employment alternatives and unreliable agriculture, open up the alternative of Artisanal and Small-scale Mining (ASM) (Dreschler, 2001). Artisanal and small-scale mining creates a range of social, economic, legal, and environmental impacts; the major concern of the latter is the uncontrolled use of mercury in gold mining Jewelry activists have influenced the Fair trade Foundation and others to produce a set of standards for responsible artisanal and small-scale mining gold and precious metal mining. The importer, jewelry manufacturer, or retailer is expected to pay a 'fair trade' premium to benefit the mining community as a whole through some appropriate project. The requirements for certification require that the miners form membership-based artisanal and small-scale mining organizations (ASMOs). It is undertaken by individuals, families, co-operatives, and small-scale entrepreneurs using rudimentary methods to win easily extractable minerals for quick cash returns (Dreschler, 2001).

2.12.1 Artisanal and Small Scale Gold Mining (ASGM):

Artisanal and Small-scale Gold Mining (ASGM) is the process of extracting gold from the ground in the absence of land rights, mining license, exploration or mining, mineral exploration permit or any legitimate document that allows the operation. The socio-economic benefits of small scale mining, which include employment and income generation, are seriously outweighed by devastating environmental costs and impacts (UNEP,1997).

ASGM covers a broad spectrum of activities which depend on size of work force, timing, methods used to carry out the operations and whether operations are legal, illegal, formal or informal. The mining is done mainly by poverty driven rural individuals, groups, families or cooperatives with minimal or no mechanization, knowledge or technology in mining and mining safety. It is commonly associated with informal, unregulated, unregistered, unlicensed, under-capitalized and under-equipped mining operations. Traditional mining artisanal scale mining is defined as an activity practiced by utilizing local traditional means within the specified area (SNAS, 2014).

2.12.2 The Environmental Impacts of Traditional Gold Mining:

Mining is an activity that employs many people in rural areas because the barriers to entry are minimal, with low technology, capital and limited specialized skills needed. Artisanal mining is associated with a number of environmental impacts, which are deforestation and land degradation, open pits which pose animal traps and health hazards, and mercury pollution, dust and noise pollution. A large proportion of artisanal miners are unaware of the laws governing mining activities and the environment Impact of Water Pollution (Yaw, 2011). Although mining, especially gold mining can be a good source of economic income, the malpractice in the process conducted can be damaging to the environment, surface and ground water resources and health of the untrained miners and communities. Careless use of chemicals, especially mercury, and disposal of polluted water, can threaten the available water resources and the food chain (Yaw, 2011).

2.12.3 The Negative Impacts of Traditional Gold Mining:

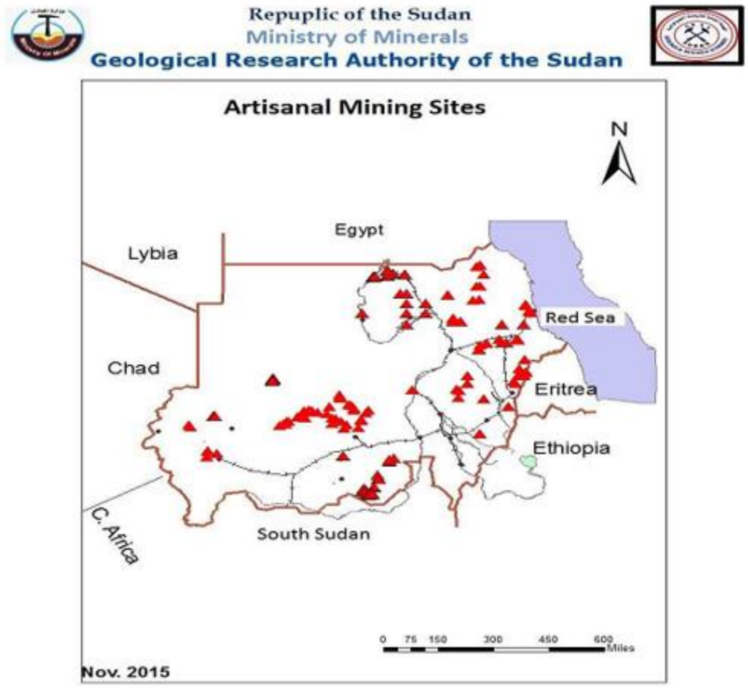
In fact, health problems among miners are worldwide phenomena spread in Australia, North America, South America, and Africa. Including frequency of cancer of the trachea, bronchus, lung, stomach, and liver, increased frequency of pulmonary tuberculosis (PTB), silicosis, pleural diseases, diseases of the blood, skin, and musculoskeletal system. All these health complications decrease the life expectancy of the gold miners, (UNDP, 2011).

Artisanal mining can contribute to poverty alleviation and provides many opportunities. It is an activity associated with many negative social impacts. Women and children are generally the most affected by these hazards. Exposures of such chemicals are also harmful to human health. According to the literature that was reviewed, the compounding environmental and health cost and damages of mining activities far outweigh their economic and social benefits, the magnitude of which cannot be quantified. There is therefore high health cost incurred as a result of mining activities. Land subsidence has resulted annually in the death of hundreds of miners, (McKeon ,*et al*.2015)

2.13 Production of Gold Mining in Sudan:

In 1990 the mining industry accounted for less than 1 percent of the total Gross Domestic Product (GDP). Non hydrocarbon minerals of actual or potential commercial value included gold, chrome, copper, iron, manganese, asbestos, gypsum, mica, limestone, marble, and uranium. Gold had been mined in the Red Sea Hills since pharaonic times. Between 1900 and 1954, several British enterprises worked gold mines in the area, and extracted a considerable quantity of the metal-one mine alone reportedly produced three tons of gold between 1924 and 1936. Gold has also been mined along the borders between Sudan and Uganda and Zaire, but not in commercially profitable amounts. During the 1970s, the government's Geological Survey Administration located more than fifty potential gold-producing sites in different parts of the country. Several joint ventures between the Sudanese Mining Corporation, a government enterprise, and foreign companies were launched in the 1980s; these undertakings produced gold at Gebeitand several other mines near the Red Sea Hills beginning in 1987. In 1988, about 78,000 metric kilograms of gold ore were mined in Sudan. In late 1990, Sudan and two French mining companies formed a joint venture company to exploit gold reserves in the Khawr Ariabwadi in the Red Sea Hills,

(https://photius.com/countries/sudan/economy/sudan_economy_mining.html)



Map(2) Geographical Distribution of Traditional Gold Mining in Sudan (https://photius.com/countries/sudan/economy/sudan_economy_mining.html)

2.14 Impact of the Artisanal Gold Mining on Socio-Economic Life in Sudan:

Mining is an activity that employs many people in rural areas, with low technology, capital and limited specialized skills needed. Miners can earn higher incomes in mining than through other traditional activities. Artisanal mining can contribute to poverty alleviation and provides many opportunities. Recent Studies point to a number of indicators attributed to the impact of gold produced on the national macro-economy: boosted GDP and economic growth, enhanced balance of trade through exports and increased employment opportunities:

- The Economic Indicators:

i. Total gold production increase with the advent of artisanal gold activities.

ii. Artisanal gold mining operations currently contributing 85% of the total national production.

iii. 12 to 15% of production comes from large and small-scale mining and tailings processing operations.

iv. Prior to 2008, productions only come from the Sudanese- French JV Ariab Mining Co. (6 MT in 2005).

- Contribution of Artisanal Gold Mining Activities to Employment:

i. A one million individuals involved in artisanal small-scale gold mining and extraction.

ii. Another 4 million of family dependents benefit from mined gold revenues.

iii. The total ASM activity-dependents (5 millions) translate to ~14% of the total population.

iv. Over 30 types of occupations are practiced within the ASM gold mining and processing centers (http://www.khartoumspace.uofk/edu/handle/123456789/18970).

2.15 Gold Mining in Butana Area:

Artisanal gold Mining activities beginning in Batana area since 2010 and some minerals were discovered by the efforts of local community, spread in many areas particular in Wad Bishara, Al-Khouili and other areas. About «250» thousands of local people work in gold mining exploration in Butana areas, in addition to that more than «26» companies are working in the gold mining exploration in same field, where Butana represented one of the most organized areas of mining exploration at the level of Sudan. Although gold mining activities in Butana area, improved the livelihoods and a good source of economic income for local community, the negative impacts in the process of exploration caused damaging to the environment, surface and ground water resources and health. Abu Aisha on 2015 stated that: "Artisanal mining is associated with a number of environmental impacts, and a large number of local community brought to the Butana area from outside the state, which lead to shortage in the provision of services, so we need to improve services in the area to counter the increased of miners that have negative impacted in the area (Almakii, 2013).

2.16 Pastoral Livelihoods in Butana:

The Butana area is composed of agro-pastoral and pastoral communities. Pastoralists are: Tribes who have cultivable land in Butana and who migrate to this land from the peripheral areas in the rainy season. They are about 250-300 Rufa'a, 60 Kawahla, 150 Umm Bararu, 50-60 Fadniya families, some Lahaweyeen, Shukrya and Musalamiya who are now based outside Butana. The latter two groups (Shukriya and Musalamiya) used to be permanently resident in the Butana but became impoverished as a result of the 1984 drought and lost most of their livestock, becoming more dependent on labour and agricultural work and thus now spend more of their time away from what they consider to be their 'home'. These families are within the Butana area for about 3-4 months per year (August-October/November), either accompanying herds or cultivating the family lands. They are mostly among the poor and average families, (ECAW, 2012).

2.17 Traditional Rain-fed Cultivation:

Five types of rain cultivation were practiced in Butana Turus, Wadi, Bildat, Harif and Mahal, the selection of which is dependent on the amount and pattern of rainfall. Each of these represented a water harvesting technique for the maximum utilization of rainwaters. Besides, mechanized farming was introduced to the southern Butana during the 1049s and irrigated agriculture was practiced along the Nile banks. The deserted rain fed projects represent an opportunity for rangeland rehabilitation and establishment of ranches. To reduce the labor demand for weeding and improve soil fertility, Turus cultivation is practiced all over Butana. It is probably the most important and involves a system of earth embankments to retain water for the longest possible period to allow penetration. This rapidly expanded with the expansion in the use of tractors in cultivation but has given way to large-scale mechanized farming in southern Butana (Fadlalla and Ahamed, 2006).

2.18 Herd Management system in Butana:

The main livestock in Butana area are cattle, sheep, goats and camels. Livestock population in the study area is about 23.239.308 heads (MARF, 2010). The nutritional requirements of the animals are met from grazing and agricultural residues. They have preference to certain plants such as *Belphares edlus* (Siha) and try to avoid poisonous plants. Marketing strategies include fattening and selling of animals by richer households, culling of low producing animals, reducing numbers during the dry season by selling old animals and reducing the number of males. Productivity of animals is generally low due to poor genetic make- up, poor nutrition and management practices, absence of breeding strategies and low fertility due to poor nutrition and reproductive disease. Compared to other areas of Sudan disease are relative important. Nonetheless due to the fact that animals enter the Butana from different states many diseases are prevalent. New practices in herd management include risk aversion behavior through reduction of stock to reduce risk of dry season loss, matching birth with rainy season, changing species of animal raised, opting for more sales of livestock during the dry season, changing mobility pattern and combining agriculture, and other occupations with livestock rearing (Fadlalla and Ahamed, 2006).

2.19 Conflicts over Resources in Butana Area:

Rangeland and water can only be utilized to the advantage of the owner’s group (Fariq), so in most cases the possibility of exclusion of outsiders is more likely when resources are limited. However, tensions sometimes occur between local tribes and other groups from outsider. The main reasons behind tension and conflicts include animal thefts, invasion of agricultural areas by animals, trespassing and intrusion of private residential areas by foreigners, misuse of the water resources by incoming nomads and misuse and/or damaging of pasture area (Fadlalla and Ahamed, 2006).

CHAPTER III

MATERIALS AND METHODS

3.1 Primary data:

3.1.1 Range Vegetation Assessment:

Materials Used

The equipment used in range vegetation assessment included Loop, 1 m² quadrate, scissors, formats and recording sheet, tape (100 m), paper bags, marker pen and pencils.

Sampling Procedures and Size:

Site survey was done to determine the range areas affected by the mining activities in the rangelands of Butana area. Based on these reconnaissance surveys, Al-Sobag area was chosen as a range site representing these rangelands. Two range sites were selected in the study area (Side A) that affected by artisanal gold mining activities (Plates (3.1) and the other one (Side B) did not affected by mining in the same zone. Each site was divided into four plots. The selections of plot location, were based on a randomly selection to represent the area of mining activities. Four lines transects with an angles 90°, 180°, 270° and 360° were determined using compass established at each range site. At each line transect, two transects of length100 m distributed systematically and four quadrates of size 1X1m placed through each transect with interval (25m) between them; and 100m between the two transects in each side.

Plates (3.1) Shows the sampling area taken in mined site in Al-Sobag area

Sources: Field Survey Oct, 2018

3.1.1.1: Ground Cover Determination:

Ground cover is generally expressed as a percentage, so that all ground cover components (bare soil, litters, rocks and plant species) add up to (100%). The ground cover was determine along each (100 m) transect, where plant species and other ground cover components were recorded with 3/4-inch parker loop hits resulting in 100 hits in each transect with interval of one meter. The readings were recorded on parker loop sheet. Measured observations along the transect line usually four types of observation which are plant species (spp), dead plants or litter (L) bare soil (BS) and rocks, (Parker, 1951).

Following formulas were used:

- ✓ Plants cover = $\frac{total\ hits\ of\ all\ plants\ specieces}{total\ hits} \times \%100$
- ✓ Percent of bare soil = $\frac{Totalhits\ of\ baresoil}{tatal\ hits} \times \%100$
- ✓ Percent of plant litters = $\frac{Total\ hits\ of\ litter}{total\ hits} \times \%100$
- ✓ Percent of rocks = $\frac{Totalhits\ of\ rocks}{total\ hits} \times \%100$

3.1.1.2 Biomass Productivity:

Biomass is a commonly measured vegetation attribute that refers to the weight of plant material within a given area. Clip and weight method (harvesting method) was used to determine biomass productivity, (Muir and McClaran, 1997). Plant material from each quadrate along all transects in each site, were harvested at a level of (2.5 cm), above ground level using scissors then put in labeled paper bags. Dry matter content was determined by drying the sample in an oven, at (105 °C, for 48 hours). The dry weight obtained using a digital balance. Productivity per hectare was calculated and estimated to determine herbaceous productivity. Plates (3.2)


Plates (3.2) Plant material from each quadrate along all transects in each site: Sources: Field Survey Oct, 2018

3.1.1.3 Seed Bank Sampling:

Four samples were taken by Augar in each of the sites. by Auger each quadrat point (25m) with three depths (0-5, 6-10, and 11- 15 cm) and put the soil samples in paper bags. Any soil samples of one soil depth were mixed and sub-sample of weight (250-g) was taken for seed extraction, Plate (3.3).

Plate (3.3): Showed soil samples by auger: Sources: Field Survey Oct, 2018

3.1.1.4 Seed Extraction:

Preliminary washing of the soil samples was done using sieves of (1.0, 0.5, and 0.25 mm) pore size, at the laboratories of the Range Department in the College of Forestry and Range Science (Sudan University of Science and Technology). The process of separation of seed from the soil comprised initial washing of the soil, floatation, and then separation of live and dead seeds based on their density using $CaCI_2$ solution. Each soil sample (250gm) was placed and filtered through three sieves of pores sizes (0.06, 0.04 and 0.03 mm), washed continuously until only seeds were left in sieves. The remaining residuals and seeds in the three sieves were immersed in water for (45 minutes); all the dead seeds floated above the water surface and were separated in the filter paper. After separating the dead seeds, placed under a slow fan for drying and storing them for identification and counting.

The remaining seeds were soaked in Calcium Chloride solution ($CaCl^2$) at a concentration of (12 ml in 250 ml) water for 45 minutes. All the live seeds floated in the solution and filtered, placed in filter papers under a slow-moving fan to dry completely. Plat (3.4).

The following formulas were used to determine the percentage of live and dead seeds:

Percentage of live seeds = $\frac{number\ of\ live\ seeds}{total\ seeds\ number} X100\%$

Percentage of dead seeds =$\frac{number\ of\ dead\ seeds}{total\ seeds\ number} X100\%$

The saves was used in washed soiles – three tipes of pore size

Plate (3.4) Showed the method of seeds extraction in the Lab

Sources: lab of plant- Soba - 2018

3.1.1.5 Seed Identification:

Extracted seeds were identified using lenses. Through comparison with key seeds and reference samples collected from plants in the study area, and then identified, counted and recorded, (Abdallah, 2008). Seed composition and seed density were calculated using the following equations:

Percentage of seed plant species = $\frac{\textbf{seeds number of plant specie}}{\textbf{total seeds number}} \text{X}100\%$

Seeds density = $\frac{\textbf{seeds number of depth } X2X1000}{\textbf{quadrate areaXquadrate number of soil depth}} = seeds/m^2$

3.1.2 Socioeconomic data:

3.1.2.1 Field Observations:

Field visits and observations were carried out in the study area during the period between October and December 2018, to assess of visual indicators (rangeland resources and vegetation cover) to assess and quantify the impact of artisanal gold mining activities, besides the general characteristics of local communities and livelihood.

3.1.2.2 Household Interviews:

Questionnaire Designed:

Structured questionnaire was designed to collect information from the household about the impact of artisanal gold mining on natural rangeland in the study area. Different issues were addressed that included; personal characteristics, education, pattern of range use, types of structure species, sources of income, impact of artisanal gold mining activities on household livelihoods, animals and rangeland.

Sampling Selection:

Three villages namely (Al-Bgaa, Al-Rbdaa, Abogola and Al-Tkoon) of Al-Sobag locality were randomly selected from the total number of villages around the gold mining activities in the study area. The sample unit was a household head and the sample was selected according to population size in each village.

Sampling Size:

A total of 60 Households randomly selected which constituted about 10% of the total number of households in the selected villages, which approximately about 600 families. The target groups, representing locality on the basis of similarities in socio- economic activities and livelihood levels.

3.2 Secondary Data:

The secondary data and information's were collected to cover the review of literature from different sources which includes textbooks, journals, reports and previous study. Other sources include internet and documents on gold mining.

3.3 Data Analysis:

Vegetation attributes, data were organized tabulated and analyzed using standard range measurements equations. All data tested by statistical analysis (ANOVA) were performed using the Duncan procedure, SAS statistical program to compare differences in vegetation attribute in the two areas and the differences between the means were compared. The socio-economic aspects data were analyzed using the Statistical Package for Social Sciences (SPSS) software (Ver.20.0) by computing descriptive statistics. The results were presented using frequency counts and percentages. The chi square test was performed to test significant of differences between respondents viewed. Data presentation was done through charts, graphs and tables.

CHAPTER IV

RESULTS AND DISCUSSIONS

4.1 Range Vegetation Assessment:

4.1.1 Ground Cover in Range Sites:

Table (4.1) showed that, there were significant differences between percentages of ground cover in terms of bare soil, rocks, litter and plant cover in the location close to the mining activities, there was an increasing in the proportion of bare soil (56.37%) compared to the plant cover (2.25%).While there are no significant differences between the components of ground cover in the range site which is far from the mining area. These results explained the negative impact of the artisanal gold mining on natural rangeland in Al-Sobag area. The increase of bare soil percentage in rangeland is a sign of range condition degradation, and indicated that there is vegetation retrogression in this area. In that manner (Fashir *et al*, (2012) found that the bare soil, increase in the grazed compares with the un-grazed area. The high bare soil percentage in the unaffected area may be as a result of increased livestock number leaded to degradation. This result agreed with Abdelsalam *et al*, (2017a) who stated that open grazing system which was practiced in Sudan rangelands had a negative impact on vegetation cover and soil conservation.

Table (4.1) The variation in average plants cover, bare soil, rocks and litter.

Vegetation Attribute	Areas	
	Mined area (A)	**Un mined area (B)**
Bare soil	56.37 a	48.75 a
Rock	16.12 a	14.12 a
Litter	20.87 b	27.25 a
Plant cover	2.25 b	9.87 a

Mean with the same litter are not significant differences at Alpha: 0.05

4.1.2 Rangeland Biomass:

The result in table (4.2) showed that, there were no significant differences in average biomass productivity for two areas (A & B). These results indicated that the range sites in the study area were affected negatively by the mining activities near or far away from the mining drilling. The remote location of mining activity may be degraded due to the intensive grazing, decrease the rangeland area. The range site near mining activity produced about (13.16 gm/m²) compared to the other range site which was located far away from the mining activity produced about (11.41 gm/m²). The rangeland in the El-Sobag mainly affected negatively by human activities. Elnour (2001) stated that livestock grazing negatively affects the plants communities' then it's not grazed in right time. He also mentioned that early livestock grazing consumes the plants in earlier stages before seed setting and tends to reduce the forage production. Grazing removes the biomass above ground production if maintained at high intensity for sufficiently long period grazing can lead to loss of plant cover, shifts in species composition or volatilization loss of soil nutrients (Steve and Chris, 2000). Intensive and courteous grazing occur in this rangeland led to loss in biomass productivity and decreased the stocking rate.(Abdelsalam, *et al*, 2017a) found that open grazing system affected negatively on range productivity and carrying capacity. According to the results showed in table (4.3) the carrying capacity of both range sites in Al-Sobag rangeland (A & B) affected negatively as a result of human misuse. The range carrying capacity near the mining area about (0.026 Au/ha/year), while the stock of unmind range site (0.022 Au/ha/year). This result explains the negative impacts of human activity in these range sites. The artisanal gold mining activities led to decrease rangeland vegetation cover and loss of biomass productivity and finally led to decrease range carrying capacity and stocking rate. The decrease of rangeland area as a result of artisanal gold mining contributed in concentration of a large number of animals in specific range sites far from artisanal gold mining activities, which led to rangeland resources degradation and decrease the carrying capacity of these sites. The artisanal gold mining in the range site it may be increased the over grazing and intensive used of range resources by concentration of livestock in limited area contributed to rangeland ecosystem retrogression. This result agreed with Abdelsalam *et al*, (2017a) who stated that open and intensive grazing of livestock had negative impacts on carrying capacity.

Table (4.2) Biomass (gm/ m²).

Source	**DF**	**Mean square**	**F.value**	**Pr>F**
Location	1	18.37	0.07	0.79(NS)
Transect	3	611.81	2.29	0.11(NS)
Quadrate	3	295.04	1.10	0.35 (NS)

(NS)= no significant differences at Alpha 0.05

Table (4.3) Average Biomass (gm/ m²) and Carrying Capacity (Au/ha/Year).

Areas	Mean Biomass (gm/m²)	Productivity (ton/ he/ year)	carrying capacity (AU/He/Year)
Mined area (A)	13.16 a	0.07	0.026
Un mined area (B)	11.41 a	0.06	0.022

Means with the same litter are not significant difference at Alpha: 0.05

4.2 Assessment of Soil Seed Bank:

4.2.1 The Soil Seed Bank:

Table (4.4) illustrated that there were no significant differences between range sites of the study area in soil seed bank (live and dead seeds). While there were significant differences between the soil depths in terms of live seeds, Pr (0.04). The significant differences found in this study it may by reflects the poor condition of both range sites, because these rangelands affected negatively by human activities such as artisanal gold mining, intensive use and over grazing occur in these rangelands. Abdelsalam, *et al* (2017b), reported that the intensive grazing pressure decreased the soil seed bank number in rangeland.

Table (4.4) Soil Seed Bank Variation between Range Sites and Soil Depth

Source	**DF**	**Mean square**		**F.Value**		**Pr>F**	
		Live seeds	Dead seeds	Live seeds	Dead seeds	Live seeds	Dead seeds
Location	1	10.66	32.66	9.14	1.25	0.09 NS	0.38 (NS)
Depth	2	24.50	36.16	21.00	1.38	0.04 *	0.55 (NS)

NS = not significant differences.

* = significant differences.

4.2.2 Live and Dead Seeds Percentage in Mining and Unmined Area of Rangeland:

The results represented in table (4.5), explains that there were no significant differences between range sites percentages of live and dead seeds. The affected range site by artisanal gold mining activities was recorded the same percentage of live and dead seeds (50%), while the unaffected range site was recorded (31.6%) and (68.4%) for live and dead seeds respectively. It observed that the mean of dead seeds in both range sites was more than 50% of the total seed bank found in these rangelands. This results it may reflects the degradation of soil seed bank stock and viability of seeds in the next growing seasons of rangeland. which considered as a retrogression indicator of range ecosystem condition. The misuses of rangeland may increase soil erosion and loosed upper layer of soil which help decrease the live seed percentage. Farahaldour, *et al*, (2019) reported that the impact of soil erosion it may cause the disappearing of seed bank.

Table (4.5) Live and Dead Seeds in Two Range Sites.

Area	Seeds Types		Seed Percentage%	
	Live	**Dead**	**Live**	**Dead**
Mined area (A)	8a	8a	50	50
Un mined area (B)	6a	13a	31.6	68.4

Means with same litter are not significant difference at Alpha 0.05

4.2.3 Soil Seed Bank Density:

Table (4.6) explains that there were significant variations in the live seed density between different soil depths. The upper soil layer (0-5 m) recorded higher live seed density (147 seeds/m^2) compared to 93 seeds/m^2 and 53 seeds/m^2 in depths (6-10 cm and 11-15 cm) respectively. The majority of soil seed density was found in the upper layer of both range sites, and it decreased with the increased of soil depth. As a compared to the total density of soil seed bank, the dead seed density was found larger than live seed density, the dead seed density recorded 427 seed/m^2 while the live seed density just reach 293 seeds/ m^2. Generally, live seeds density were less than dead seeds, this indicated that the artisanal gold mining activities it may led to decreased soil seed bank in the Butana rangelands.

Table (4.6) The Seed Density (Seed / m^2) in Different Soil Depth:

Soil Depth (cm)	Number of Seeds		Seed Density seed/m^2	
	Live	**Dead**	**Live**	**Dead**
0-5	11a	15a	147a	200a
6-10	7ab	9a	93ab	120a
11-15	4b	8a	53a	107a
Total	22	32	293	427

Means with same litter are not significant difference at Alpha 0.05.

4.2.4 Contribution of Range Plant Species in Seed Bank of Range Sites:

Table (4.7) illustrated that there were four species found in the upper level of soil seed bank (0-5 cm) as a live seeds, at range site affected by mining activities compared to five plant species occurred in remotely range site from mining activities. The higher species compositions of live seeds in upper soil layer were *Indigofera ochstetteri*, *Schoenefeldia gracilis* and *Amaranthus spp* recorded (36.3, 27.3 and 27.3%) respectively. While the higher species compositions at unaffected range site were *Chloris virgate* (27.3%), *Indigofera* *ochstetteri* (27.3%), *Chloris virgate* and *Aristida adscensianis* recorded the same parentage (18.2%). The dead species in the upper depth of soil was found *Indigofera ochstetteri* contributed about (60%) of species composition at the range site close to mining area, compared to unaffected range site the proportion of dead seed composition recorded to *Aristida adscensianis* about (63.8%). Beside the previous species found in upper depth of soil, there are two species appeared in the middle depth of soil (6-10 cm) were *Echinochloa colona* and *Dactyloctenium aegyptium* at affected range sites contributed about (33.33%) and (22.22%) of live seeds respectively. The higher species composition of the middle depth at the remotely range site from the mining area were *Indigofera ochstetteri* contributed about 50% of dead seeds and *Echinochloa colona* contributed about 40% of the total live seeds in this depth. The dominant species composition of live seeds at the mining area in depth (11-15 cm) was *Amaranthus spp* recorded about (40%), followed by *Indigofera ochstetteri*, *Schoenefeldia gracilis* and *Echinochloa colona* recorded the same percentage (20%). On the other hand, the highest contribution of plant species in dead plants was *Echinochloa colona* (42.8%), and the second were *Chloris virgate* and *Amaranthus spp* both recorded (28.6%) of the total species composition found in this depth. There are two species had a higher contribution of dead seeds in the third depth such as *Echinochloa colona* and *Indigofera ochstetteri* represent (50%) and (37.5%) of the total botanical composition respectively, Appendix (6). This result explained the poor diversity of species in Al-Sobag rangeland subjected to the misuse of rangeland resources. Many management intervention and practices need to rehabilitate these degraded rangelands and increase species diversity.

Table (4.7) Soil Seed Bank Botanical Composition

Botanical Name	Mined Area		Unmind Area	
	Live %	Dead %	Live %	Dead %
Upper Depth (0-5 cm)				
Indigofera ochstetteri	36.3	60.0	27.3	13.6
Schoenefeldia gracilis	27.3	20.0	00	4.5
Chloris virgata	9.1	20.0	27.3	13.6
Amaranthus spp	27.3	00	18.2	4.5
Aristida adscensianis	00	00	18.2	63.8
Eragrostis tremula	00	00	9.0	00
Total	**100**	**100**	**100**	**100**
Middle Depth (6-10 cm)				
Indigofera ochstetteri	0.00	11.11	0.00	50.0
Schoenefeldia gracilis	11.11	22.22	20.0	16.7
Chloris virgata	11.11	0.00	20.0	0.00
Amaranthus spp	22.22	44.44	0.00	33.3
Dactyloctenium aegyptium	22.22	0.00	0.00	0.00
Echinochloa colona	33.33	0.00	40.0	0.00
Aristida adscensianis	0.00	22.22	0.00	0.00
Eragrostis tremula	0.00	0.00	20.0	0.00
Total	**99.99**	**99.99**	**100**	**100**
Last Depth (11-15 cm)				
Indigofera ochstetteri	20.0	0.00	0.00	37.5
Schoenefeldia gracilis	20.0	0.00	0.00	0.00
Chloris virgata	0.00	28.6	0.00	0.00
Amaranthus spp	40.0	28.6	0.00	12.5
Echinochloa colona	20.0	42.8	0.00	50.0
Total	**100**	**100**	**0.00**	**100**

4.3 Socio-Economic Aspects of local Communities:

4.3.1 General Characteristics of Household:

4.3.1.1 Gender Distribution:

The Results in figure (4.1) showed the majority of the respondents were male, with percentages of (76.7%), while (23.3%) were females. This result indicates that the pastoral community in study area is comprehensively dependent on males for their economic activities, especially in agricultural work, grazing animals and mining. While the women were practices informal small-scale income earning activities to supplement their household's income, in addition to their responsibility to look after children, collection of firewood, take care of small animals, and milking.

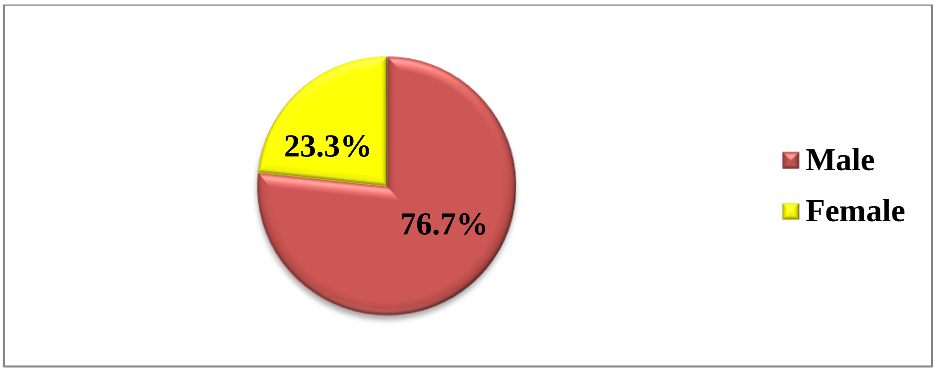


Figure (4.1) Distribution of respondents according to the gender

*Df= 59 sig= .000

*NS=Not significant (p<0.05, significant=.0, high significant=.00, highly significant=.000

4.3.1.2 Age Groups of the Respondents:

Figure (4.2) shows that, there were highly significance differences at P (.000) among the household according to their age grouping. The largest percentage (33.3%), of respondents ages range between (31- 40) years. fallowed by (26.7%) of those ages over 50 years, (26.7%) of those aged between(20-30) years and the lowest percentage of those aged between (41-50) years who represented (15%). This shows that majority of the respondents fall within working age and is still productive; this might be as a result of their occupation which requires an active age group.

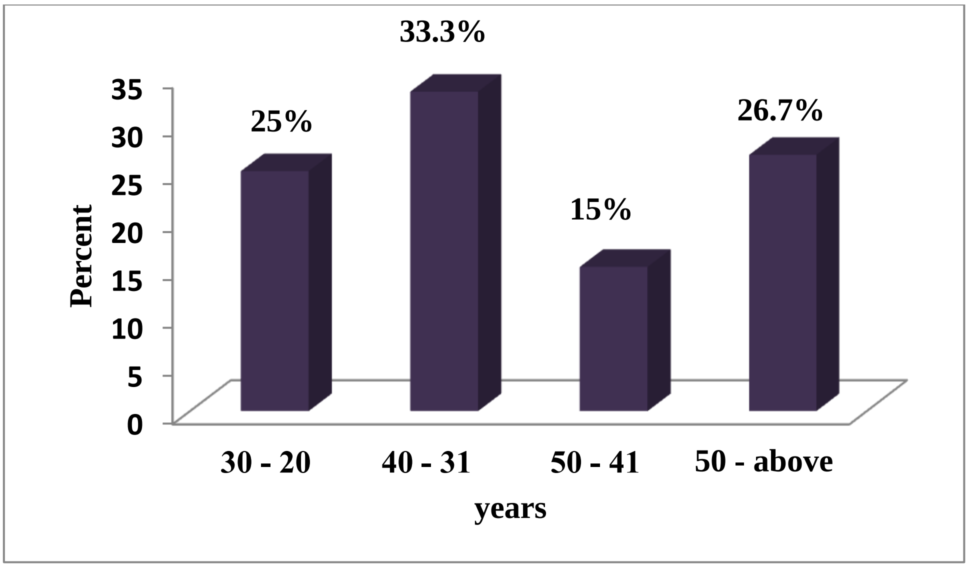


Figure (4.2) Age groups of respondents

*DF= 59 sig= .000

*NS=Not significant (p<0.05, significant=.0, high significant=.00, highly significant=.000

4.3.1.3 Education Levels of Respondents:

Results represents in Figure (4.3) showed that there were highly significant differences at P (.000) among respondent according to their education level. Most of the respondents had their education level up to the primary or basic level, where they represented (46.7%) followed by illiteracy and Khalwa, they similar percentage (18.3%), then secondary (13.3) and university (3.3%), which indicates that the education levels is very high. It is clearly positive that a growing number of children went to school in the area. This may be, explained the fact that almost all the communities in the study area care about importance of education for their children. These results indicate the possibility of raising environmental awareness among the respondents in order to understand the environmental risks resulting from traditional gold mining on natural resources, especially natural rangelands. Durmuş-Özdemir, (2016), reported that the education is significant in understanding the hazards that threaten the environment and suggesting solutions for such risks and raising awareness on environmental matters.

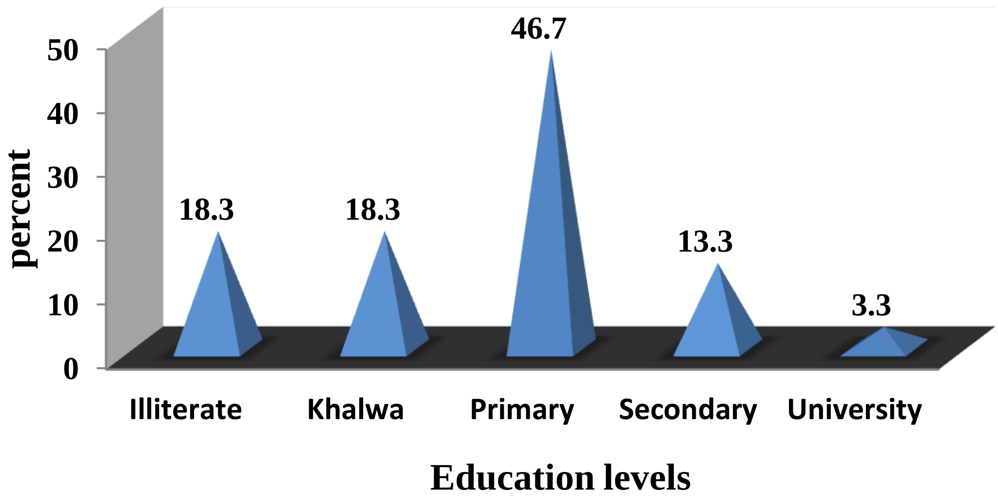


Figure (4.3) Education level of respondents

*Df= 59 sig= .000

*NS=Not significant (p<0.05, significant=.0, high significant=.00, highly significant=.000

5.4.2 Livelihoods Activities of Household:

Table (4.8) showed that there were highly significant differences at P (.000) among respondent in the study area, based on their opinions about the source of their income. The majorities of them were depending on livestock raising and crops production. The main source of income for the head of household was animal rearing (83.3%), this may be explain that, respondents were depend mainly on herding animals, followed directly by (76.7%) of them depend on rain fed agricultural activities, then about (33.3%) of them were traders and (20%) were involved recently in artisanal gold mining activities, specially the respondents in villages within the active mining sites, agreed that the positive impacts of mining exploitations are construction of houses and infrastructural development like Al-Rbdaa village. In this regard, Meaza and Demssie,(2015) inferred that artisanal gold mining has positive and adverse effects on livelihoods of local communities, landless youths and migrants.

Table (4.8) Main Sources of Income

Sources	Frequency	Percent	DF	Sig
Agricultural Activities	46	76.7	59	.000
Livestock Raising	50	83.3		
Mining Exploitation	18	30		
Trade	20	33.3		

*NS=Not significant (p<0.05, significant=.0, high significant=.00, highly significant=.000

5.4.3 Kind of Livestock Owned by Households:

The result in Figure (4.4) showed that there were highly significant differences at P (.000) among respondent according to types of herd structure which is represented by (60%) of respondents were herding sheep followed by (48.3%) goats then about (13.3%) herding camels and few of them (10%) were herding cattle, and others about (36.7 %) were herding (donkeys). Herding different types of livestock may be attributed to the reasons that, goats and sheep are more tolerant to household life and environment in the study area; in addition to that sheep and goats were more marketable and help to earn money compared with other types. These results agree with (Le Houerou, 1980) who stated that, different animal species fill different ecological niches and therefore may be more efficient than a single species.

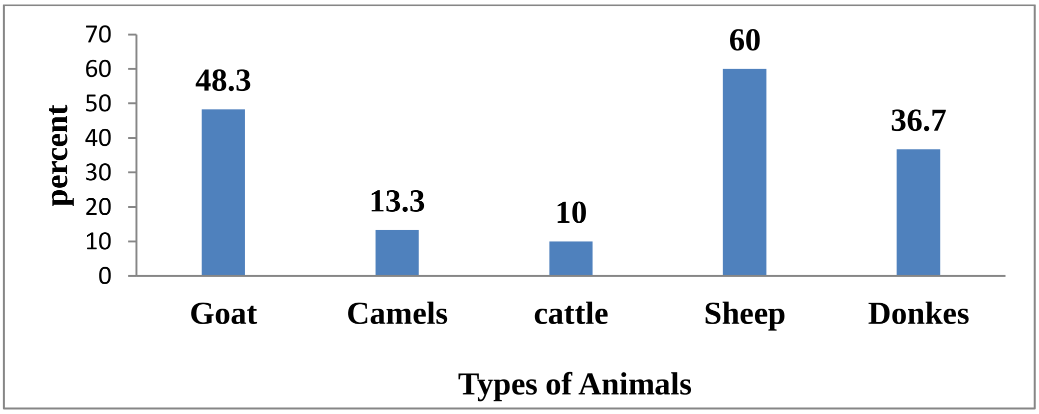


Figure (4.4) Type of herd structure owned by the respondents

*Df= 59 sig= .000

*NS=Not significant (p<0.05, significant=.0, high significant=.00, highly significant=.000

5.4.4 Grazing Patterns Practiced:

The results represent in table (4.9) showed that there were highly significant differences at P (.000) among respondents about the grazing patterns that practices by households in the study area. The majority of respondents about (79.7%) were practice grazing in sedentary pattern, because the whole area was a rangeland belonging to the population, with some areas allocated for cultivating sorghum and some vegetables to meet the pastoralists' need for food and utilization of residues crops as forage for animals, while the nomadic pattern only (7%) and semi- sedentary were (13.3%) of them. The reasons behind the settlement of nomads is one of the indictors of the recent changes in the study area, due to declining in livestock numbers, access to education and water services, and repeated drought. Also they settled because they lost their main assets (animals) due to socio-political marginalization.

Table (4.9) Grazing Patterns Practices by Households.

Grazing Patterns	Frequency	Percent	DF	Sig
Nomads	4	7	52	.000
Sedentary	48	79.7		
Semi sedentary	8	13.3		
Total	**60**	**100**		

*NS=Not significant (p<0.05, significant=.0, high significant=.00, highly significant=.000

5.4 .5 Artisanal Gold Mining:

5.4.5.1 Starting Time of Artisanal Gold Mining Exploration:

The results represent in table (4.10) showed that there were highly significant differences at P (.000) among respondents' opinions. The majorities (66.7%) of respondents said they were starting and practice of artisanal gold mining activities in study area since the year (2009-2010) up to now, which almost 10 years ago and (30%) of them were practices of artisanal gold mining activities for five years ago. This result indicate in more recent years the pastoralists were involved in artisanal gold mining and exploration activities in 2009 in order to diverse sources of income and improve their livelihoods. Pringle, *et al*, (1990) who stated that, mining activity occurs very widely over relatively small areas of the rangelands. However, it is an intense land use which can create significant off site effects. Mining activity is not a general factor influencing every pastoral business. However, where mining activity occurs on a pastoral lease it can have a negative impact on the pastoral business, quality of life for the pastoralist and the rangeland resource.

Table (4.10) Periods of Exploitation and Extraction of Artisanal Gold Mining by Households.

The Periods	Frequency	Percent	DF	Sig
Before 5 years	2	30.3	59	.000
Before 10 years	40	66.7		
Before 15 years	0	1.7		
Before 20 years	0	1.7		
Total	60	100.0		

*NS=Not significant (p<0.05, significant=.0, high significant=.00, highly significant=.000

5.4.5.2 Methods Used for Exploitation Gold:

The results represent in figure (4.5) showed that there were highly significant differences at P (.000) among respondents about gold methods. It is clear that majorities of respondents (60%) were used traditional and simple tools and mechanize methods in the processing and extraction of gold, followed by (35%) worked through traditional method and only (5%) of them used of machines. The study indicated that there are two types of workers they used both traditional tools and huge machines, those who work individually or work under the umbrella of an investor, group of investors, and companies. These processes reduced the amount of agricultural land available and pastoral activities in the surrounding areas used by local people considerably. Aryee *et al*. (2003) reported that work in artisanal gold mining operations involves the uses of simple manual tools of shovels, pickaxes, hammers, chisels and pans in both surface and underground environments.

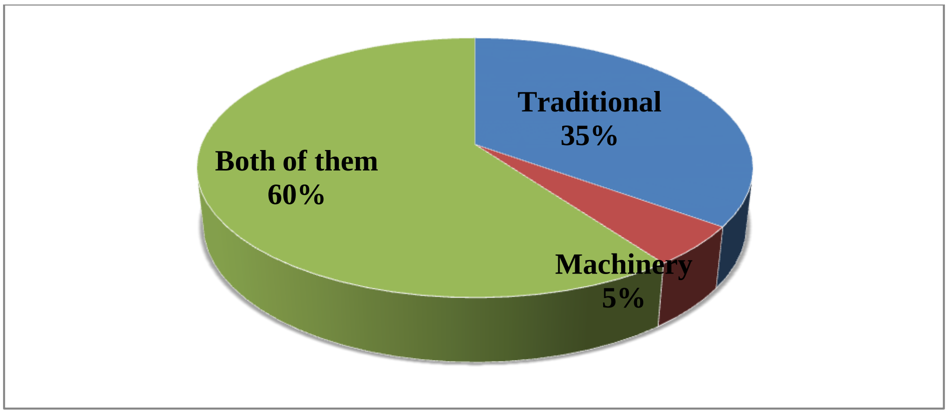


Figure (4.5) Types and methods of artisanal gold mining exploitations in El-Sobag.

*Df= 59 sig= .000

*NS=Not significant (p<0.05, significant=.0, high significant=.00, highly significant=.000

5.4.5.3 The Impacts of Artisanal Gold Mining Activities on Rangeland Area:

The result in table (4.11) shows that, there are highly significant differences among respondent. It is noteworthy that the rangelands before mining activity in Al-Sobag was (68.3%) excellent. Respondent refer to there were very palatable plants and high nutritional value are absent such as *Blepharis edulis* (Saha) *Ipomoea belpharosepla* (Hantot) and *Ipomoea cordofana* (Taber), while (20%) of the respondents indicated that the pasture was decries and started to increase and (11.7%) confirmed that there is no change.

Table (4.11) The Conditions of Rangeland before mining started.

The Conditions	Frequency	Percent	DF	Sig
Excellent	41	68.3	59	.000
Decreased	12	20.0		
No change	7	11.7		
Total	60	100.0		

*NS=Not significant (p<0.05, significant=.0, high significant=.00, highly significant=.000

Figure (4.6) showed that there were highly significant differences among household about the current condition of rangeland resources. The majority of respondents (61.7%) said the rangelands were deteriorated after artisanal gold mining appeared in Al-Sobag area, also (55%) them confirmed that the range plants were decreased, where some plants began to appear ex: *Aristida spp* (gabash) - *Tribulis terrstris* (draisa) *Cassia senna(*sanamaka) and *Ipomoea cordofana* (Turba).

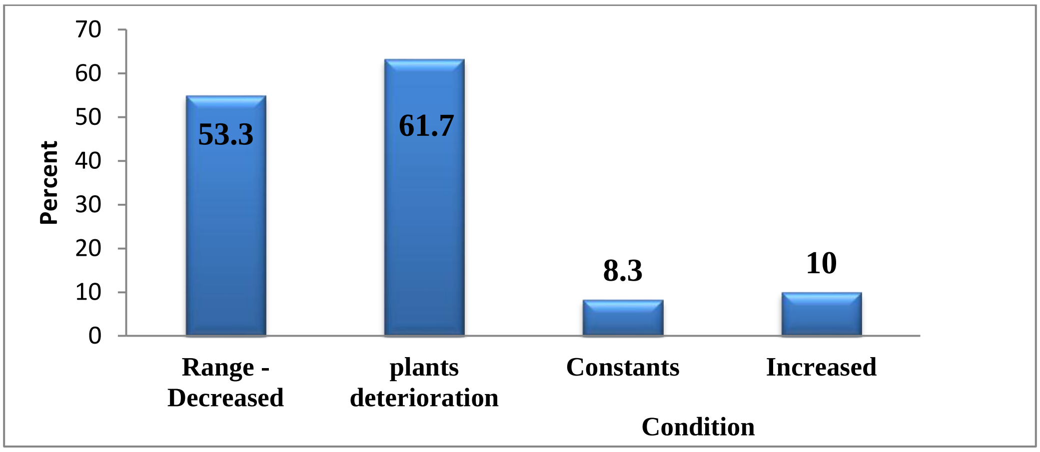


Figure (4.6) The Current Condition of Range after Mining Exploitation.

*DF= 59   sig= .000

*NS=Not significant (p<0.05, significant=.0, high significant=.00, highly significant=.000

5.4.5.4 Impact of Artisanal Gold Mining Exploitation on Soil:

The results in table (4.12) showed that there were highly significant differences at P (.000) among respondents about the effect of gold exploitation in rangeland soil. The majority of respondents (58.3%) within the active mining sites agreed that there are negative impacts of artisanal gold mining exploitations on soil of rangeland, clear in forms of big pits, which usually begins with the removal of the vegetation cover used both the surface and deep soil for mining, followed by (48.3%) of them answered that its clear in loss of soil fertility, while (33.3%) of respondents agree that soil degradation occurs in the form of accelerated water erosion and (28.3%) of them said that soil degradation sign as Sand dune .Thus, badly controlled of gold mining methods and activities can destroy soil and living resources leaving behind. Artisanal gold mining exploitations make a serious problem in the study area. These results reflects negatively on vegetation cover, biomass productivity and vegetation diversity in Butana rangeland. According to the (USDA,2000) which stated that, soil quality on rangeland can effects plant production, reproduction, mortality, erosion, water yields, water quality, wildlife habitat, carbon sequestration, vegetation changes, establishment and growth of invasive plants and rangeland health.

Table (12) Impact of Artisanal Gold Mining Exploitation on Soil.

Impact on Soil	Frequency	Percent	DF	Sig
Soil Erosion	20	33.3	59	.000
Sand Dune	17	28.3		
Decrease Soil Fertility	29	48.3		
Hole	35	58.3		

*NS=Not significant (p<0.05, significant=.0, high significant=.00, highly significant=.000

5.4.5.5 Impacts of Artisanal Gold Mining on Livestock:

Table (4.13) showed that there were very high significant differences at P (.000) among respondents between their opinions about the impacts of artisanal gold mining activities on livestock in the study area. According to their opinions the study revealed that about (95%) of respondents agreed that gold mining activities affected negatively on the animal correlated the problems facing livestock. About (53.3%) said that the impact clear in decreased of rangeland areas followed by (46.7%) answered that it was reflected in forms of water, air pollution and diseases with same percentages. (45%) of the respondents mentioned that the impacts results in leg broking and mortality of animals, while (25%) of the respondents agreed that impact in decreased of production for animals. This result agreed with Peterson and Heemskerk, (2002) who reported that the vegetation cover was transformed into intensive gold mining areas. Finally about (11.7%) respondents said that the effect of artisanal gold mining seems in reducing and blocking of animals routs, which often lead to severe conflicts between pastoralist and farmers and more complex for free movement of livestock in the study area, therefore the nomadic using means of transport in the movement of animals. These results explains that there are several problems facing livestock in the study area especially in villages within the active mining sites as a result of artisanal gold mining exploitations.

Table (4.13) The Most Common Effects on Animals in the study area.

Impact on Animals	Frequency	Percent	DF	Sig
water and air pollution	28	46.7	59	.000
decreased of rangeland	32	53.3		
decreased of animals roots	7	11.7		
Diseases	28	46.7		
Animals broking and deaths	27	45		
decreased of production	15	25		

*NS=Not significant (p<0.05, significant=.0, high significant=.00, highly significant=.000

5.4.5.6 Impacts of Artisanal Gold Mining on the Health of Community:

According to the results showed in Figure (4.7) illustrated that there were highly significant differences at P (.000) among respondents opinions regarding to community health. The majorities of respondents (85%) said that mining exploitation had impacted negatively in human health. About (45%) of them agreed that artisanal gold mining had promoted the spread and growth of these diseases such as malaria, diarrhea and typhoid fever by were the main threats to community health in the localities. These could be due to the fact that the miners are leaving pits with water which form breeding grounds for mosquitos which in turn bringing malaria across the localities. Also (56.7%) of respondent said that artisanal gold mining exploitation had brought changes in the color and taste of their water by pollution. Both man and animals can be seriously, affected by pollution from these sources, particularly by heavy metal contamination of drinking water. Another impact mentions by (26.7%) of respondents was the possibility of contamination by cyanide and other liquids that would mix with surface water and hence pose a danger for both humans and animals and only (20%) of them stated that toxic dust fall out as the result from artisanal gold mining operations and extraction lead to death of vegetation, crops and livestock and the effects on public health can also be serious. These results similar to (Stephens and Ahern, 2001) studies of surface mining focus on coal, granite and rock mining and health risks related to dust breathing. In all levels of mining health risks occur with dust exposure,

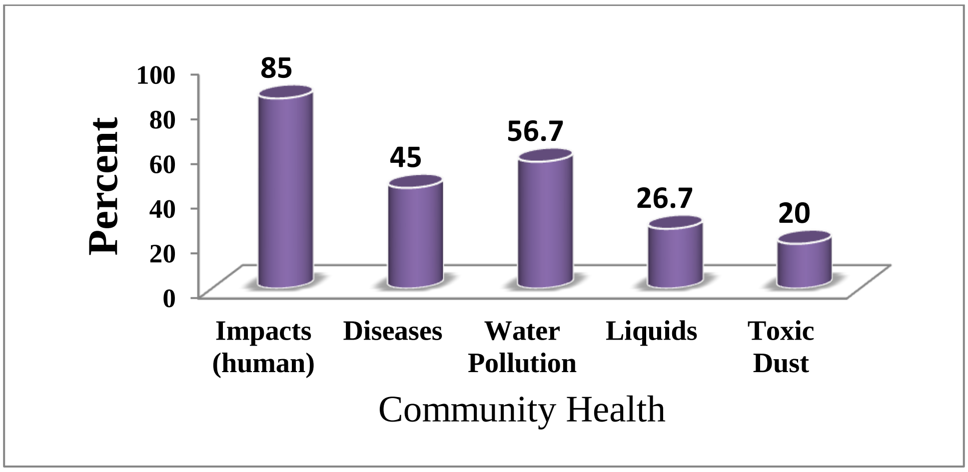


Figure (4.7) Impact of artisanal gold mining exploitation on community health.

*DF= 59 sig= .000

*NS=Not significant (p<0.05, significant=.0, high significant=.00, highly significant

5.4.6 Vegetation Types:

The results expressed in table (4.14) showed that there were very highly significant differences at P(.000) among respondents about forms of vegetation cover in the study area. The existing vegetation cover includes trees, grasses and different annual plant species (shrubs). The majority of households (76.7%) answered that the dominant vegetation cover from grasses such safollowed *Indigofera hochstetteri (*Shraya), *Schoenefeldia gracilis* Kunth, *Echinochloa colona*, *Dactyloctenium aegyptium Aristida adscensianis, Aristida adscensianis* (Gaw), *Indigofera hochstetteri*,*Chloris virgate*, *Chenopodium album*, (70%) of them mentioned that the vegetation cover compose of main trees species which includes *Acacia seyal, A. Senegal, A. nilotica, Ziziphuss pina*-christi- *Balanites aegyptiaca, Grewia tenax*, while more than fifty percentages (51.7%) of respondent said the annual plant species (shrubs) such as *Acacia mellifera* , *Acacia nilotica, Acacia senegal Acacia seyal*, *Acacia tortilis*. are most widespread in the study area. This agreed with O‟Farrell *et al*, (2007) reported that different animal species have different preferences for grazing material; this preference could be on plant species, plant parts, and on grazing location within the rangeland.

Table (14) Structure and Types of Vegetation Cover in Study Area.

Types of Vegetation	Frequency	Percent	DF	Sig
Shrubs	31	51.7		P(.000)
Trees	42	70.0		
Grass	46	76.7		

*NS=Not significant (p<0.05, significant=.0, high significant=.00, highly significant=.000

5.4.7 Water Sources:

The result in table (4.15) shows that the majorities (98.3%) of respondent said they depend on man-made ponds (Hafirs) as main sources more than other water sources. These may be attributed to that,(Hafirs) can keep water for long time during all rainfall period approximately about (6 months).While about (91.7%) of them mentioned that they used (wells) these may be during shortage rainy season or in dry season grazing areas and few of respondents (13.3% - 3.3%) said they use Dams and Dounkies respectively. They may use in period of rainfall a few days. IFAD, (2006), reported that the water sources were very important for both human consumption and livestock production especially man-made ponds (Hafirs) that are used to store water from ephemeral streams and/or rainfall overland runoff.

Table (15) Main Sources of Water in the Study Area.

Sources of Water	Frequency	Percent	DF	Sig
Hafeer	59	98.3	59	.321
Dam	8	13.3		.000
Dounki	2	3.3		.000
Wells	55	91.7		.024

*NS=Not significant (p<0.05, significant=.0, high significant=.00, highly significant=.000

5.4.8 Other Causes of Rangeland Degradation:

According to the results in Figure (4.8) there were highly significant differences at Pr (.000) among respondents in term of others causes that lead to degradation of rangeland resources in Butana area. The majority of respondents mentioned that there are majors other reasons than gold mining activities causes degradation of rangeland resources in forage production in particular, (63.3%) respondents answered that shortage of rain fall and distributions is rank one of the main causes, followed by (43.3%), said that the degradation comes due to seasonal fire, about (40%) agreed that expansion of rain-fed agriculture, also more than (30%) of them explained that conflicts over resources due to high competition between different users and only (6.7%) said that the sign of rangeland resources degradation are very clear as indicated of increased settlement and population pressure in the study area in recent years. These results agreed with (IFRPI and IFAD, (2006)) which report that rangeland degradation by many reasons, due to that a large numbers of pastoralists have migrated from their villages searching water and fodder; in addition to that many local people abandoned the animal breeding due to low income, inefficiency production, and poor production system and rangeland degradation. In consequence the pastoralists face increasing poverty, decreasing food energy and conflicts among land users. On the other hand, the population increase in the area associated with increasing demand for food production in rangeland, resulting in more pressure on the rangeland resources. Similarly other studies (Meier *et al.* 2007) highlight that decreased vegetation is associated with growth of pastoral conflict in the Africa. Meadows and Hoffman,(2003), stated that, it is important to consider the potential impact of changing climates, especially with respect to rainfall distribution and quantity.

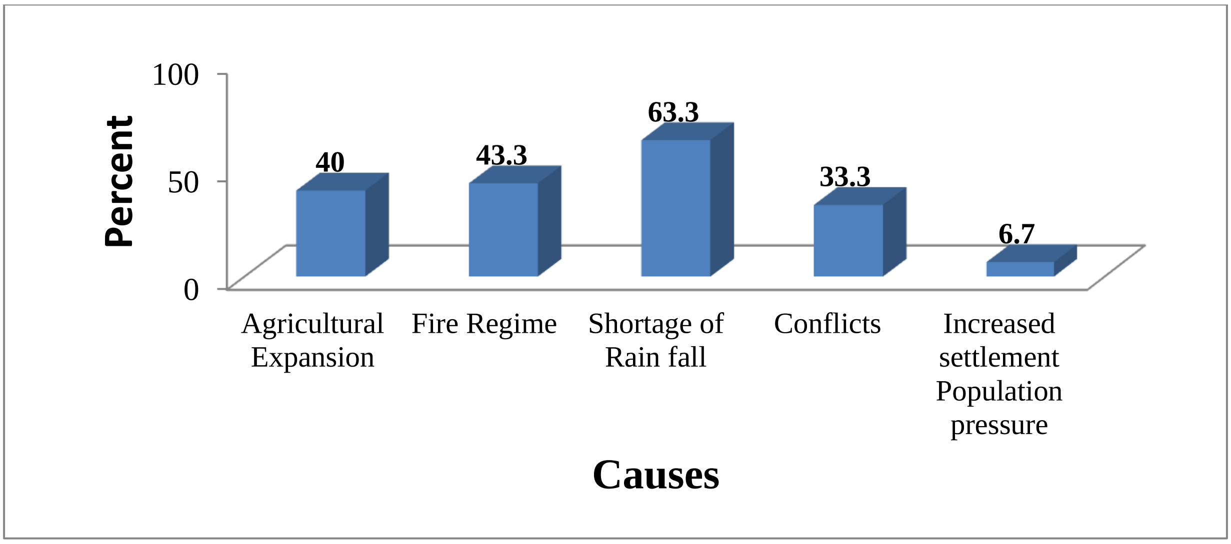


Figure (4.8) Other causes of rangeland degradation**.** *DF= 59 sig= .000

*NS=Not significant (p<0.05, significant=.0, high significant=.00, highly significant

CHAPTER V

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions:

Based on results obtained from this study it concluded that:

- The increase of bare soil percentage, vegetation cover retrogression and decrease biomass productivity and range carrying capacity in the study range sites were main range condition indicators of the impact of artisanal gold mining in these rangelands.
- The misuses may increase soil erosion and loosed upper layer of soil and attributed to decrease the live seed percentage.
- Live seeds density were less than dead seeds, this indicated that the artisanal gold mining activities it led to decreased soil seed bank in Al-Sobag rangelands.
- The higher species compositions of live seeds in upper soil layer were *Indigofera ochstetteri*, *Schoenefeldia gracilis* and *Amaranthus spp* recorded (36.3, 27.3) and (27.3%) respectively. While the higher species compositions at unaffected range site were *Chloris virgate* (27.3%), *Indigofera ochstetteri* (27.3%), *Chloris virgate* and *Aristida adscensianis* recorded the same parentage (18.2%).
- The dead species in the upper depth of soil was found *Indigofera ochstetteri* contributed about (60%) of species composition at the range site close to mining area, compared to unaffected range site the proportion of dead seed composition recorded to *Aristida adscensianis* about (63.8%).
- The majority of respondents (61.7%) said the rangelands were deteriorated after gold mining appeared in study area.

5.2 Recommendations:

- Companies involved in artisanal gold mining activities should introduce development projects such as portable water, schools, hospitals, good roads, markets, communications facilities within the mining sites in the area.
- Reseeding the range sites with the desirable plant species.
- Rehabilitation efforts are required to overcome the impacts of artisanal gold mining activities on sustainable range land management in study area and other areas affected.
- An integrated land use plan should be devised in the study area.

- Creation of awareness across the active mining areas on the negative impacts of artisanal gold mining.
- Law enforcement agents should ensure proper application of the laws and regulations that guide artisanal gold mining activities at government level.
- Establish the suitable solution to this impacts in order to promote sustainable management of natural rangeland
- Further studies on the impact of artisanal gold mining on water quality.

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Appending's and Annexes

Appendix (1) Range Inventory Form (Loop Form)

Site ………………………….   Date ………

Transect number ……………..   Group ……

Spp = Plants species   R = Rock

L = litter   Bs = Bare soil

Site   **Description**

…………………………………………………………………………………………………

…………………………………………………………………………………………………

……….

Appendix (2) Range Inventory Form (Quadrate Form)

Site …………………………. Date ………

Quadrate number …………….. Group ……

Q. No	Cover %	Species found	Q. No	Cover %	Species found
1			6		
2			7		
3			8		
4			9		
5			10		

Site description

:…………………………………………………………………………………………………

………..

Appendix (3) Biomass Production Forms (weight/g)

Site	**Transect (no)**	**Sample (no)**	**Weight/g**
Total			

Appendix (4) Questionnaire

بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College Graduate Studies of

استبيان لجمع معلومات من المجتمعات المحلية – محلية البطانة– ولاية القضارف

((هذه المعلومات سرية ولا تستخدم إلا بغرض البحث))

Impacts of Gold Mining on Rangeland Vegetation and Local Communities in Al-Sobag Area, Gedarif State, Sudan

Researcher Name:…………………… Location:…………………….

Date:………………………………… State:………………………..

Province:…………………………….. Locality:…………………......

Tribe: ………………………………...

- **The first axis: economic and social data for the local population**

Gender: Male ☐ Female ☐

Age: 40-31 ☐ 30-20 ☐

Above 50 ☐ 50-41 ☐

Education level:

Illiterate ☐ Khalwa ☐ primary ☐ Secondary ☐ University ☐

The Main Sources of Income:

Farmers ☐ Traders ☐ Animal rearing ☐ Mining ☐

Marital status

Married ☐ Unmarried ☐ Difurs ☐ Wedow ☐

- **The second axis: the activities practiced by the local communities in the region**

Do you rearing animals

Yes ☐ NO ☐

Grazing pattern do you practices

Nomads ☐ Sedentary ☐ Semi sedentary ☐

What Type of Animals do you Rearing

Cattle ☐ Sheep ☐ Goat ☐ Camels ☐ Others ☐

Do you practice agriculture activities

Yes ☐ No ☐

If yes defined the crops

- **The third axis: the impact of indigenous mining on the change in vegetation and land cover in the area**

When do you started mining:

Before 5 years ☐ Before 10 years ☐ Before 15 years ☐ Before 20 yeras ☐

Methods of mining:

Traditional ☐ Machinery ☐ All of them ☐

Describe Range Conditions when Mining Started

Exlant ☐ Decreased ☐ No change ☐

The Plant before the Mining:

....

....

Describe the current condition of range

Range-decreased ☐ Plants deterioration ☐ Constants ☐ Increased ☐

Current plants:

....

....

Are there was palatable plants were Disappears

Yes ☐ No ☐

If the answer is yes, then mention it

....

....

The Component of Dominant Plants:

Trees ☐ Shrubs ☐ Grass ☐

Other reason for natural rangeland deterioration

Presented ☐ No presented ☐

Reason for rangeland deterioration:

Agricultural expansion	
Fire regime	
Shortage of rain fall	
Conflicts	
Others	

❖ **The fourth axis: problems and damages caused by civil mining on soil, humans and animals**

The impacts of mining on rangeland soil :

Soil erosion ☐ Sand dune ☐ Decrease soil fertility ☐ Hole ☐

Are there was impacts of mining on human

Yes ☐ No ☐

Types of impacts on human:

diseases ☐ water pollution ☐ appending animal rearing ☐ conflicts ☐

Are there any conflicts during grazing practices

Yes ☐ No ☐

The reason of conflicts

....

....

Are there any conflicts during grazing practices

Find ☐ Not find ☐

The reason of conflicts

....

....

Is the forage produced in rangeland is enough

Enough ☐ Not enough ☐

Source of forage during dry season

crops residues ☐ green forage ☐ constraint ☐

Sources of animal water -

Hafeer ☐ Dam ☐ Dounki ☐ Weels ☐

Are there animal roots

Yes ☐ No ☐

If there are, define names, path and the locations it passes through

....

....

The reason of animals roots absent

....

....

The impacts of mining on Animals

water and air pollution		Decreased of rangeland		Decreased of animals roots		Diseases		Animals broking and deaths		Decreased of production	

❖ **The fifth axis: the role of rangeland management and related authorities in developing rangelands and pastoral communities in the region**

Are there was any range improvement activities in the area

Yes ☐ No ☐

Types of rangeland improvement activities

Fire line ☐ Water sources preparation ☐ seed broadcasting and seedling ☐ Invasive plants ☐ Others ☐

Do you participate in any extension programme

Yes ☐ No ☐ Absent ☐ Don't know ☐

Is there any implementation for extension program focusing rural development

Yes ☐ No ☐

If yes? Mention those programs that have been implemented?

....

....

The role of civil administration in land utilization

Exest ☐ Not Exest ☐

If they exist, then their role

....

....

Appendix (5) One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
sex	4.238	59	.000	.23	.12	.34
age	9.735	59	.000	1.43	1.14	1.73
Education level	12.305	59	.000	1.65	1.38	1.92
farmers	4.238	59	.000	.23	.12	.34
treaders	10.863	59	.000	.67	.54	.79
animal rearing	3.435	59	.001	.17	.07	.26
mining	11.733	59	.000	.70	.58	.82
martal status	3.542	59	.001	.37	.16	.57
do you rearing animals	3.227	59	.002	.15	.06	.24
grazing pattern do you practices	16.507	52	.000	1.08	.94	1.21
what type of animals do you rearing - cattle	25.028	58	.000	.92	.84	.99
what type of animal do you rearing - sheep	6.272	59	.000	.40	.27	.53
what type of animal do you rearing - goat	7.942	59	.000	.52	.39	.65
what type of animal do you rearing - camlls	19.583	59	.000	.87	.78	.96
what type of animal do you rearing - others	10.095	59	.000	.63	.51	.76
do you practice agriculture activities	4.632	59	.000	.27	.15	.38
x10.1	6.056	59	.000	.38	.26	.51
x10.2	16.212	59	.000	.82	.72	.92
when do you starte mining	10.171	59	.000	.75	.60	.90
methods of mining	10.192	59	.000	1.25	1.00	1.50
descripe range conditions when mining started	4.810	59	.000	.43	.25	.61
x14.1	6.056	59	.000	.38	.26	.51
x14.2	10.095	59	.000	.63	.51	.76
x14.3	13.923	59	.000	.77	.66	.88
x14.4	17.176	59	.000	.83	.74	.93
x14.5	7.429	59	.000	.48	.35	.61
x14.6	7.185	59	.000	.47	.34	.60
x14.7	14.605	59	.000	.78	.68	.89

x14.8	17.176	59	.000	.83	.74	.93
x14.9	6.948	59	.000	.45	.32	.58
x14.10	10.863	59	.000	.67	.54	.79
x14.11	15.362	59	.000	.80	.70	.90
x14.12	23.043	59	.000	.90	.82	.98
x14.13	13.923	59	.000	.77	.66	.88
x14.14	16.212	59	.000	.82	.72	.92
x14.15	11.733	59	.000	.70	.58	.82
x14.16	17.176	59	.000	.83	.74	.93
x14.17	17.176	59	.000	.83	.74	.93
x14.19	21.136	59	.000	.88	.80	.97
x14.20	18.285	59	.000	.85	.76	.94
x14.21	23.043	59	.000	.90	.82	.98
x14.22	25.475	59	.000	.92	.84	.99
x14.23	21.136	59	.000	.88	.80	.97
x14.24	25.475	59	.000	.92	.84	.99
x14.25	14.605	59	.000	.78	.68	.89
descripe the currnt condition of range - decreased	6.996	58	.000	.46	.33	.59
descripe the currnt condition of range - plants detrirattion	5.873	58	.000	.37	.25	.50
descripe currnt condition of range - conistant	25.028	58	.000	.92	.84	.99
descripe currnt condition of range - increased	22.635	58	.000	.90	.82	.98
x16.1	6.717	59	.000	.43	.30	.56
x16.2	10.863	59	.000	.67	.54	.79
x16.3	16.212	59	.000	.82	.72	.92
x16.4	19.583	59	.000	.87	.78	.96
x16.5	23.043	59	.000	.90	.82	.98
x16.6	23.043	59	.000	.90	.82	.98
x16.7	19.583	59	.000	.87	.78	.96
x16.8	13.923	59	.000	.77	.66	.88
x16.9	21.136	59	.000	.88	.80	.97
x16.10	13.923	59	.000	.77	.66	.88
x16.11	33.481	59	.000	.95	.89	1.01
x16.12	19.583	59	.000	.87	.78	.96
x16.13	21.136	59	.000	.88	.80	.97
x16.14	25.475	59	.000	.92	.84	.99
x16.15	28.740	59	.000	.93	.87	1.00
x16.16	23.043	59	.000	.90	.82	.98
x16.17	25.475	59	.000	.92	.84	.99

x16.18	18.285	59	.000	.85	.76	.94
x16.19	19.583	59	.000	.87	.78	.96
x16.20	25.475	59	.000	.92	.84	.99
x16.21	23.043	59	.000	.90	.82	.98
x16.22	33.481	59	.000	.95	.89	1.01
are thers was palatable plants were desapperat	4.646	58	.000	.27	.15	.39
x18.1	7.185	59	.000	.47	.34	.60
x18.2	12.216	59	.000	.72	.60	.83
x18.3	9.407	59	.000	.60	.47	.73
x18.4	12.216	59	.000	.72	.60	.83
x18.5	11.733	59	.000	.70	.58	.82
x18.6	18.285	59	.000	.85	.76	.94
x18.7	18.285	59	.000	.85	.76	.94
x18.8	17.176	59	.000	.83	.74	.93
x18.9	12.216	59	.000	.72	.60	.83
x18.10	21.136	59	.000	.88	.80	.97
x18.11	21.136	59	.000	.88	.80	.97
x18.12	23.043	59	.000	.90	.82	.98
x18.13	28.740	59	.000	.93	.87	1.00
x18.14	21.136	59	.000	.88	.80	.97
x18.15	18.285	59	.000	.85	.76	.94
x18.16	18.285	59	.000	.85	.76	.94
x18.17	18.285	59	.000	.85	.76	.94
the componant of domenant plants - shrabs	7.429	59	.000	.48	.35	.61
the componant of dominant plants - trees	5.028	59	.000	.30	.18	.42
the componant of dominant plants - grass	4.238	59	.000	.23	.12	.34
other reason for natural rangeland detriruration	2.317	58	.024	.08	.01	.16
reason for rangeland detrioration - agricultural expansion	9.407	59	.000	.60	.47	.73
reason of rangeland detrioraton - fire regime	8.784	59	.000	.57	.44	.70
reason of rangeland detrioration - shortage of rain fall	5.844	59	.000	.37	.24	.49
reason of rangeland detrioration - fonfilcts	10.863	59	.000	.67	.54	.79
reason of rangeland detrioration - others	28.740	59	.000	.93	.87	1.00

the impacts of mining on rangeland soil - soil eorasion	10.863	59	.000	.67	.54	.79
the impacts of mining on rangeland soil - sand dune	12.216	59	.000	.72	.60	.83
the impacts of mining on rangeland soil - decreas soil fartility	7.942	59	.000	.52	.39	.65
the impacts of mining on rangeland soil - hole	6.492	59	.000	.42	.29	.55
the impacts of mining on human	3.227	59	.002	.15	.06	.24
types of impacts on human - diseases	8.492	59	.000	.55	.42	.68
types of impacts on human - water pollution	6.717	59	.000	.43	.30	.56
types of impacts on human - apanding animal rearing	12.738	59	.000	.73	.62	.85
types of impacts on human - confilcts	15.362	59	.000	.80	.70	.90
are there any confilcts during grazing practices	10.468	59	.000	.65	.53	.77
the reason of confilcts	7.778	24	.000	2.20	1.62	2.78
are the was animals diseases in mining areas	1.762	59	.083	.05	-.01	.11
x28.1	7.429	59	.000	.48	.35	.61
x28.2	9.088	59	.000	.58	.45	.71
x28.3	41.364	59	.000	.97	.92	1.01
x28.4	15.362	59	.000	.80	.70	.90
x28.5	23.043	59	.000	.90	.82	.98
x28.6	21.136	59	.000	.88	.80	.97
x28.7	18.285	59	.000	.85	.76	.94
x28.8	19.583	59	.000	.87	.78	.96
x28.9	41.364	59	.000	.97	.92	1.01
x28.10	28.740	59	.000	.93	.87	1.00
x28.11	41.364	59	.000	.97	.92	1.01
x28.12	23.043	59	.000	.90	.82	.98
x28.13	11.733	59	.000	.70	.58	.82
x28.14	41.364	59	.000	.97	.92	1.01
x28.15	33.481	59	.000	.95	.89	1.01
x28.16	41.364	59	.000	.97	.92	1.01
x28.17	33.481	59	.000	.95	.89	1.01
x28.18	28.740	59	.000	.93	.87	1.00
x28.19	19.583	59	.000	.87	.78	.96

is the forage produced in rangeland is enough	19.583	59	.000	.87	.78	.96
source of dry season forange shortage - crops resduse	7.185	59	.000	.47	.34	.60
source of dry season forange shortange - green forange	9.742	59	.000	.62	.49	.74
source of dry season forange shortage - contstraint	10.095	59	.000	.63	.51	.76
sources of animal water - hafeer	1.000	59	.321	.02	-.02	.05
source of animal water - dam	19.583	59	.000	.87	.78	.96
sources of animal water - Dounki	41.364	59	.000	.97	.92	1.01
sources of animal water - x31.4	2.316	59	.024	.08	.01	.16
are there animal cludor root s	23.043	59	.000	.90	.82	.98
name of animals roots x33.1	41.364	59	.000	.97	.92	1.01
name of animals root x33.2	41.364	59	.000	.97	.92	1.01
name of animals root x33.3	41.364	59	.000	.97	.92	1.01
name of animals root x33.4	41.364	59	.000	.97	.92	1.01
X33.5	33.481	59	.000	.95	.89	1.01
X33.6	41.364	59	.000	.97	.92	1.01
the reason of animals roots absent	11.359	48	.000	2.27	1.86	2.67
the impacts of mining on aimals - water and air pollution	8.211	59	.000	.53	.40	.66
the impacts of mining on animals - decreased of rangeland	7.185	59	.000	.47	.34	.60
the impacts of mining on animals - decreased of animals roots	21.136	59	.000	.88	.80	.97
the impacts of animals on animals - diseases	8.211	59	.000	.53	.40	.66
the impacts of mining on animals - animals deaths	8.492	59	.000	.55	.42	.68

the impacts of mining on animals - decreased of production	13.304	59	.000	.75	.64	.86
are there was any range inprovement activites in the area	5.669	59	.000	.38	.25	.52
types of rangeland improvement activites - fire line	11.733	59	.000	.70	.58	.82
types of rangeland improvement activites - in water sources prepration	9.088	59	.000	.58	.45	.71
types of rangeland improvement activites - seed brosgasting and seedling	7.942	59	.000	.52	.39	.65
types of rangeland improvement activites - invative plants	59.000	59	.000	.98	.95	1.02
types of rangeland improvement activites - others	41.364	59	.000	.97	.92	1.01
do you participate in any extansion programme - i paticipate	9.843	59	.000	1.13	.90	1.36
are there any emplementation for extansion program fucsing rural development	9.742	59	.000	.62	.49	.74
name of programme that emplemented - x40.1	13.304	59	.000	.75	.64	.86
name of programme that emplemented - x40.2	18.285	59	.000	.85	.76	.94
name of programme that emplemented - x40.3	41.364	59	.000	.97	.92	1.01
X40.4	59.000	59	.000	.98	.95	1.02
X40.5	33.481	59	.000	.95	.89	1.01
X40.6	28.740	59	.000	.93	.87	1.00
X40.7	33.481	59	.000	.95	.89	1.01
the role of civil adiministration in land utulization	8.492	59	.000	.55	.42	.68
types of civil admiministration role	15.481	38	.000	3.69	3.21	4.18

Appendix (6) Plants Cover Before and After Gold Mining Activities in Al-Sobag Area

Scientific Name	Local name	Before	After
Trees and Shrubs			
Acacia tortilus,	Smour		×
Acacia seyal	Taleh		×
Acacia mellifera	Keter		
Acacia nilotica	Sonut		
Ziziphus spina-christi	Seder		
Sclerocarya birrea	Homaad		×
Grewia tenax	Godaimm		×
Acacia nubica	Laoot	×	
Prosopis chilensis	Missket	×	
Herbs and Grasses			
Blepharis edulis	Sehaa		×
Blepharis linariifolia	Bggael		×
Chenopodium album	Hantoot		×
Schoenefeldia gracilis	*Gabash*		
Sorghum purpureosericeum	Adar	×	
Indigofera ochstetteri	Shrayaa		
Crotalaria sphaerocarpa	Safary		×
Schoenefeldia gracilis	DnubAlnagaa		×
Chloris virgata	Afun Alkhdeem		×
Amaranthus spp	Lssan Altaer		
Dactyloctenium aegyptium	Abu Asabee		×
Echinochloa colona	Defraa		×
Aristida adscensianis	Gaw, Humra		
Eragrostis tremula	Bnoo		×
Boerhavia coccinea	Turba		
Tribulis terrstris	Draissa		
Rhyncosia minima	Adan Alfaar		×
Cassia senna	Sanamaca		

Digera muricata	Lablab Ahmar		×
Schima ischaemoides	Dambllab		×
Chrozophora brochiana	Argacii		×
Setaria pallide-fusca	Danab Alfluo		×
Setaria verticilata	Karmoshabe		×
Sporobolus marginatus	Abu Malhee		×
Sorghum purpuresericum	Anees		×
Ischaemum brthyacherum	Boos		×
Justicia palustris	Fkhaa		
Brachiaria lata	Tfaa		
Leucas urticifolia	Um Gallot	×	
Cymbopogon proximus	Mhraab		
Chorchorus trilocularis	Khudra		
Portulaca oleracea	Reglla		
Solanum dubium Fresen	Gobain		
Cymbopogon nervatus	Nall		
Euphorbia hirta	Mlbana	×	
Xanthium brazilicum	Ramtok	×	
	فقوس	×	
	صوقيت	×	
	ابوفريرة	×	
	عرق - ابوعفين	×	

Not: ✓ Means species appear × Means species disappear