

Original article

Anthropogenic and Climatic Factors: as Causes of Drought Disaster in Sudan

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Abstract

Sudan is a typical of least developed countries in Africa in being highly vulnerable to climate change and climate variability. It has suffered a number of long and devastating droughts in the past decades, which have undermined food security and are strongly linked to human displacement and related conflicts. The vulnerability to drought is exacerbated by the tendency to maximize livestock herd sizes rather than quality, and by the lack of secure water sources such as deep boreholes that can be relied on during short dry spells. This paper is an attempt to highlight the acute problem of inefficient drought management. It relies on critical reviewing of the available literature and personal experience of the author. It is caused by man-made (anthropogenic), as well as, natural factors. Man – made factors can be confined to deforestation and its related activities. Other man- made factors can be summed up as follows: over-cropping, overgrazing, overexploitation of ground water. Natural factors can be represented in the dry periods alternated with wet periods. Drought and desertification has resulted in soil degradation. These factors led to an increase in the recurrence of natural disasters that are accompanied with loss of life and personal properties, manifestation of diseases, poverty and malnutrition as well as negative socioeconomic impacts and social unrest. Remedies can be drawn through strengthening early warning systems and adoption of sustainable agricultural practices and reforestation programmes and using renewable energy sources which are abundant in Sudan.

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Introduction

Most of disasters experienced by Sudan are of ecological nature such as drought and floods, etc. The second type of disasters experienced by Sudan is man-made disasters. These include disasters associated with mismanagement of natural resources, wars and conflicts. Drought is a frequent hazard, it causes life threatening and brings series of events and reactions that create devastating cycles of environmental collapse, conflicts and displacement (Hamid and Eltayeb, 2007).

Over 80% of the Sudan's population lives in rural areas depending on agriculture and livestock. Sudan history of drought

is so frequent e.g. 1906 famine, 1984/ 85 famine and different droughts during 1989, 1990, 1997, 2000 and 2011. The total area considered as drought prone is about 69,000 km² and this area produces 90% of the cultivated food crops and 85% firewood. In 1984 drought for instance, 8.5 million people were affected and 7.8 million livestock were lost (Eltohami, 2007).

In Sudan, desertification is clearly linked to conflict, as there are strong indications that the hardship caused to pastoralist societies by desertification is one of the underlying causes of the current war in Darfur. Together with other countries in the Sahel belt, Sudan has suffered a number of long and devastating droughts in

the past decades. All regions have been affected, but the worst impacts have been felt in the central and northern states, particularly in Northern Kordofan, Northern state, Northern and Western Darfur, Red Sea and White Nile states. The most severe drought occurred in 1980-1984, and was accompanied by widespread displacement and localized famine. According to USGS, (2000), localized and less severe droughts (affecting between one and five states were also recorded in 1967-1973, 1987, 1989, 1990, 1991, 1993 and 2000).

Objective

This paper aims to identify the causes and effects of drought disaster in Sudan.

Materials and Methods

Materials

The study area

Average monthly temperatures in Sudan vary between 26°C and 36°C. The hottest areas, where temperatures regularly exceed 40°C, are found in the northern part of the country. The dominant characteristic of Sudan's climate is a very wide geographical variation in rainfall in the north, annual precipitation ranges from close to zero near the border with Egypt, to approximately 200 mm around the capital, Khartoum. Sand and dust storms that can cover vast regions and last for days at a time are a defining feature of this low rainfall belt. Twenty-nine percent of Sudan's total area is classified as desert, 19% as semi-desert, 27% as low rainfall savannah, 14% as high rainfall savannah, 10% as flood region (swamps and areas affected by floods) and less than one percent as true mountain vegetation. These figures were counted before the separation of Southern Sudan (Zakildeen and Elhassan, 2015).

Sudan faces great environmental problems that result from climate change (e.g. desertification of semi-desert to desert, that was observed in Northern Darfur and Northern Kordofan). This was resulted from degradation of existing semi-desert environments, including wadis and oases (at least 29% of Sudan is already true desert). Within this large area, however, there are hundreds of smaller wetter regions. Conversion of land types from semi-desert to desert by human action, over-exploitation of semi-desert environment through deforestation, overgrazing and

cultivation resulted in habitat conversion to desert even though rainfall may still be sufficient to support semi-desert vegetation. In Sudan, desertification is clearly linked to conflicts, as there are strong indications that the hardship caused to pastoralist societies by desertification is one of the underlying causes of the current war in Darfur. Given the severity of the impact of such events and processes, there is a clear and urgent need for improved climate analysis, disaster prediction and risk reduction for Sudan in general, and for Darfur in particular. The current and forecast impact of desertification is poorly understood. Major efforts are required to investigate, anticipate and correct this phenomenon (Elsiddig, 2001). Drought and desertification have their impacts on soil, biodiversity, forests and food security.

Soil degradation: Five types of soil degradation have been identified: wind erosion, water erosion in flood plain areas, and depletion of soil fertility, salinity and alkalinity.

Diminishing Biological Diversity: It should be pointed out that there are no recent regular survey of fauna and flora of the Sudan and most of information presented is largely based on speculations. It is generally believed that flora and fauna has been subjected to serious destruction particularly in armed conflicts areas that are occurring in the habitat of most of these species.

Socio-economic impact: destruction of rural livelihood, loss of life, food insecurity, malnutrition, famine, rural-urban migration. All this had resulted in development of shanty towns and illegal settlements, increased pressure on the already deteriorated infrastructures and poor health conditions accompanied with appearance of marginal jobs, increase in crime levels and social instability as well as sociocultural transformation and ruralisation of urban centres (UNEP, 2007).

Methods

This paper is mainly dependent on critical review of the available literature as well as the personal experience of the author.

Results and discussion

Causes of drought in Sudan: Drought is found to be caused by two sets of factors: Anthropogenic (man-made) and climatic factors.

A) Man –made factors:

According to Eltohami (2007), these factors were confined to deforestation and its related irrational human activities.

Deforestation and reduction of rainfall are thought to be the direct impact of the excessive removal of vegetation cover. The irrational human activities include commercial wood-fuel and charcoal production, oil exploration, road constructions, using non-sustainable agricultural practices and trade liberalization had resulted in the increase of cultivable lands. Fuel wood vendors in Red Sea State and deforestation are a major cause of land degradation in desert environments. Tree cover is concentrated in seasonal wadis, where it helps retain soil that would otherwise be swept away by wind and flash floods.

Over-cropping Since land has been used to be cultivated without any rest regardless of low yield attained.

Overgrazing Animal population in Sudan as well as in Darfur, though there are no accurate figures, has increased substantially. This increase is due to:

Firstly, the preventive animal health services provided by the government veterinary authorities, (implementation of animal vaccination campaigns against pandemic diseases. Secondly, the demand for mutton and beef by the Arab and other Gulf countries has encouraged animal breeders to invest in their animals to improve productivity. This investment was mainly in disease control by the use of veterinary drugs and medicines, improvement of performance through selection of good breeds and fattening in some areas.

In North Darfur and in the areas where successive millet harvest failures are a factor, the settled farmers shifted to small animal raising (goats and sheep) as a risk avoidance strategy. Moreover, the terms of trade between animal and millet - the staple food in the region- shifted in favour of the animals in most years (one sheep of 6 months for 1.5 sacks of millet, and one year male goat for 1 to 0.8 sacks) in average years. This encouraged the millet farmers to be keen about their crops residue not being utilized communally by the nomads' livestock.

Because the livestock production in Sudan is based on communal grazing, unfortunately no investments have been made by the government or the animal breeders to improve the pasture, especially by the nomads. Nomads have continued to depend on natural grazing. So this increase in the animal population ultimately affected the carrying capacity of the natural grazing

lands.

Range and Pasture Range and pasture is the backbone of livestock production in the Sudan in general and Darfur in particular. The growth of forage plants and grazing grasses undoubtedly depends on the rainfall. And due to the droughts and shortage of rains in the last thirty years, the productivity of natural pasture has decreased. In North Darfur, for example, the carrying capacity of pasture in the seventies was forty to fifty animal units per square kilometre in the eastern sandy soils (one animal unit is three hundred- four hundred animal live weight). For comparison, the survey carried out by the Range and Pasture Department conducted in 2001/2002, which was an above average rainy season, the result of the carrying capacity was only 9 animal units per year. The deterioration was not limited to grasses, but included a decrease in the production of trees in form of pods and leaves which normally add over thirty percent to range carrying capacity. This decrease was due to the death of the trees as the result of the droughts or due to continuous felling of trees for firewood and charcoal which became one of the important economic activities and source of income for most of the poor rural populations in Darfur, settled people and nomads as well.

Regarding the decrease in the pasturelands, some estimates recorded that in the qoz soils, the decrease is over sixty per cent and the in clay and in the wadi lands, the decrease is over that an additional sixty percent. Because of the changing situations and relations between agriculture and livestock raising, severe competition between the two economic activities is undoubtedly inevitable. Therefore friction and conflicts between the stakeholders is the ultimate result. And in the Darfur context, the natural resource base conflicts are aggravated by the political dimension, the existing crisis in Darfur being an example.

Animal Routes Animal routes in Darfur are areas between the farms plots designated for nomads to pass through during their movements from south to north during rainy season and from north to south during the dry season. This arrangement was agreed upon by the local leaders of the nomads and the settled farmers in early 1950s. This arrangement then was fostered by the Government and enforced by all parties. The arrangement continued facilitating effectively the movement of the nomads without serious implications, apart from minor conflicts, which were normally resolved by traditional mechanisms until the late

1970s. Generally, the animal routes agreed upon and established in Darfur were eleven passages on the eastern and western parts of Jebel Marra Plateau. Overgrazing is found to be caused by extraordinarily increase in animals' number.

Over-exploitation of ground water especially if the water is not from renewable source i.e. fossil water

Tribal Conflicts and civil war It is acknowledged that there are many factors that contribute to conflict in Sudan that have little or no link to the environment or natural resources.

These include political, religious, ethnic, tribal and clan divisions, economic factors, land tenure deficiencies and historical feuds. In addition, where environment and natural resource management issues are important, they are generally contributing factors only, not the sole cause for tension (Eltohami, 2013).

Four natural resources closely linked to conflict in Sudan (UNEP, 2007)

In Sudan, four categories of natural resources are particularly linked to conflict as contributing causes:

1. Oil and gas reserves;
2. Nile waters;
3. Hardwood timber; and
4. Rangeland and rain-fed agricultural land (and associated water points).

Potential conflicts over oil, Nile waters and hardwood timber are national-scale issues. Tensions over rangeland and rain-fed agricultural land are primarily local, but have the potential to escalate and exacerbate other sources of conflict to the extent of becoming national-scale issues, as is presently the case in Darfur.

Competition over oil and gas reserves

Though the major north-south conflict started well before oil was discovered in central Sudan, competition for ownership and shares in the benefits of the country's oil and gas reserves was a driving force for the conflict and remains a source of political tension today.

Timber and the war economy

While there is no indication that timber has been a major contributing cause of the instigation of conflict in Sudan, there is clear evidence that revenue from hardwood timber sales helped sustain the north-south civil war. Timber became part of the war economy, and there are now signs that this process is being

repeated with charcoal in Darfur. Overall however, the timber-conflict linkage in Sudan is considered to be mainly an environmental impact issue (rather than a conflict catalyst).

Local conflicts over rangeland and rain-fed agricultural land

Local clashes over rangeland and rain-fed agricultural land have occurred throughout Sudan's recorded history. In the absence of demographic and environmental change, such conflicts would generally be considered a social, political or economic issue and not warrant an assessment purely on environmental grounds. However, environmental issues like desertification, land degradation and climate change are becoming major factors in these conflicts. Water is the most precious natural resource in the drier regions. Goats, cattle and camels all use this crowded water point in Southern Kordofan. To survive in these regions, pastoralists must travel across agricultural areas to find water and fodder for their herds, which commonly leads to conflict.

B. Climatic changes:

Recent research has indicated that the most likely cause of these historical droughts was a medium-term (years) change in ocean temperature, rather than local factors such as overgrazing. Therefore, the potential for such droughts to occur again remains. Even though 2006 was a relatively 'good' year, this small dam in Western Darfur dried up completely. Rain only falls during four months of the year, so surface reserves do not last through the dry season.

During the geological history of the country the climate has changed considerably. Dry periods alternated with wet periods. During the wet periods all vegetation zone shifted northwards while during dry periods they shifted southwards. The interaction of multiple stresses such as endemic poverty, economic system degradation, complex disasters and conflicts and limited access to capital, markets, infrastructure and technology have all weakened people's ability to adapt to changes in climate. Factors that lead to food insecurity are divided into climatic and non-climatic factors. The former factors are: decrease in annual precipitation, change in number of rainy days, delay in the start of the rainy season. Non-climatic factors contribute to vulnerability of communities in different parts of Sudan including: increase in poverty levels and lack of income diversity (UNEP, 2007)

Annual climate variability and drought

Insufficient and highly variable annual precipitation is a defining feature of the climate of most of Sudan. Between the mid – 1970s and late 2000, summer rainfall has decreased by 10-20%, across parts of western and southern areas placing already food insecure population at greater risks. This decline can be visualized in three ways: as a contraction of the regions receiving adequate rainfall for viable agricultural Livelihoods, as a map for anticipated changes in rainfall and as time series plots of selected regions.

A variability analysis of rainfall records from 1961 to 1990 in Northern and Southern Kordofan found that annual precipitation ranged from 350 to 850 mm, with an average annual variation of 65 percent in the northern parts of Northern Kordofan and 15 percent in the southern parts of Southern Kordofan. Annual variability and relative scarcity of rainfall – in the north of Sudan in particular – have a dominant effect on agriculture and food security, and are strongly linked to displacement and related conflicts. Drought events also change the environment, as dry spells kill otherwise long lived trees and result in a general reduction of the vegetation cover, leaving land more vulnerable to overgrazing and erosion.

Much Warmer Air Temperature

Temperatures have increased by more than 1 degree Celsius across much of central and southern Sudan. Under normal conditions, with plenty of available water, energy from the sun causes evaporation of water from the soil and transpiration of water vapour from leaves. As already high temperature rise, the environment becomes less hospitable to plants. These warming effects can combine with decrease in rainfall to reduce evapotranspiration and crop yields. Over the past 20 years, declines in evapotranspiration are large for the extended Darfur region (approximately 40%). Therefore, temperature increases intensity impact of drought (USGS, 2000)

The impact of drought and desertification:

Together with other countries in the Sahel belt, Sudan has suffered a number of long and devastating droughts in the past decades. All regions have been affected, but the worst impacts have been felt in the central and northern states, particularly in Northern Kordofan, Northern state, Northern and Western Darfur, and Red Sea and White Nile states. The most severe drought

occurred in 1980-1984, and was accompanied by widespread displacement and localized famine. Localized and less severe droughts (affecting between one and five states) were also recorded in 1967-1973, 1987, 1989, 1990, 1991, 1993 and 2000]. Isolated drought years generally have little permanent effect on the environment. In the case of central Sudan, however, the eighteen recorded years of drought within the last half-century are certain to have had a major influence on the vegetation profile and soil conditions seen in 2006(Zakildeen and Elhassan, 2015). However, major impacts of drought can be summarized as follows:

1. Climate-based conversion of land types from semi-desert to desert

The scale and duration of the reduction in rainfall noted above is sufficient to have changed the natural environment, irrespective of human influence. This type of change occurs as a regional process, where less drought-resistant vegetation gradually dies off or fails to reproduce, resulting in a lower-density mix of different species. In a shift as rapid as that observed in Northern Darfur and Northern Kordofan, this is manifest first and foremost in the widespread death of trees during drought events, which are not followed by recovery. This has been the case for Acacia senegal, the tree that produces gum Arabic), for example. The limited figures available indicate a southward shift in desert climate of approximately 100 km over 40 years.

2. Degradation of existing desert environments, including wadis and oases

At least 29 percent of Sudan is already true desert. Within this large area, however, are hundreds of smaller wetter regions resulting from localized rainfall catchments, rivers and groundwater flows.

3. Conversion of land types from semi-desert to desert by human action

Over-exploitation of semi-desert environments through deforestation, overgrazing and cultivation results in habitat conversion to desert, even though rainfall may still be sufficient to support semi-desert vegetation. In Sudan, a particular problem has been the conversion of dry and fragile rangelands into traditional and mechanized cropland.

Regional differences in soil types and topography also play a part in this complex three-pronged process. The soil in the north and

west of Sudan, for instance, is sandy and prone to water and wind erosion, while the south and east have more resistant clay soil. In addition, mountain ranges such as the Jebel Marra plateau form high rainfall watersheds in otherwise arid areas.

Moderate to severe land degradation is ongoing in the desert and semi-arid regions that cover the northern half of Sudan;

- A 50 to 200 km southward shift of the boundary between desert and semi-desert has occurred since rainfall and vegetation records began in the 1930s. This shift, however, has not been well quantified and is based largely on anecdotal evidence and small-scale studies;
- The desert and semi-desert boundaries are expected to continue to shift southwards due to declining precipitation/reliability of precipitation;
- Most of the remaining semi-arid and low rainfall savannah on sand, representing approximately 25 percent of Sudan's agricultural land, is at considerable risk of further desertification, to the extent that food production in these regions will at minimum plateau, and more likely continue to drop significantly (i.e. up to 20 percent or more); and food insecurity will only increase in these regions (UNEP, 2007).

4. Conclusions and recommendations

While climate-related desertification cannot be easily addressed, desertification due to human activity can be limited through appropriate land use planning and regulation, to avoid overexploitation of fragile semi-desert regions. Nevertheless the following recommendations can be drawn:

1. Community preparedness and application of sustainable knowledge to cope with drought
2. Better early warning systems are needed
3. Better agricultural practices should be adopted
4. The government should propose sufficient strategic stock in drought famine susceptible areas

5. Adoption of reforestation and forestation programmes in areas exposed to drought hazards and famine

6. Adoption of efficient agricultural and rural development programmes in areas subjected to drought hazards and famine and resettle the total area population to reduce their impacts on environment and halting rural-urban migration to avoid deterioration on urban environments and adverse socioeconomic impacts.

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