Journal of Novel Applied Sciences
Available online at www.jnasci.org
©2015 JNAS Journal-2015-4-11/1142-1148
ISSN 2322-5149 ©2015 JNAS

The impact of Climate change on pastoralist's livelihood in South Kordofan State, Sudan

Ogal Sabil Ali Maalla[1], Ali Musa Abakar[1],Yousif M.Hamdi[2] , Maruod E. Maruod[1*] and Osman Elsaid adlan[1]

1- Faculty of Natural Resources and Environmental Studies, University of Kordofan, elobeid, Sudan
2- Faculty of Natural Resources and Environmental Studies, Peace University, Alfula, Sudan

***Corresponding author*:** Maruod E. Maruod

ABSTRACT: Livestock generally serves a number of purposes to rural people. It is an asset, recognized by all, thus provides prestige and collateral for socio/economic engagements. In spite of the importance of livestock sector, pastoralists face a number of challenges that hinder their way of life and stifle their ability to adapt to changes in their external environment. The current study was directed to focus on the climate change impact on pastoralist's livelihoods in South Kordoan State, besides, assessing the socio-economic impacts of climate change on pastoralists household. A social survey was done based on a representing sample of (264) questionnaire distributed to the household of pastoralist in three routes with the study area. Data were analyzed using descriptive statistics and regression. The results revealed that the majority of the respondents (98.2%) confirmed that the Range capacity had decreased, on other hand 91.1% indicated that livestock was the main source for their livelihood with small portion of trade and crops selling. The study also showed that more than 90% of the respondents reported deterioration and changes in their traditional routes due to many reasons including expansion of agriculture (49.8%), war and conflict (27.4%) and decrease in Range productivity (17.7), lack of drinking water (2.5). The results of regression analysis showed that the coefficient of determination R^2 was 88% which means that the factor included in the model explain 88% of the change in size of herd owned by the pastoralist. The overall test of significance of the model was significant at P (0.01.). The study recommended diversification in the activities and the animal type to cope with the impacts of climate change.

***Keywords*:** Pastoralists, South Kordofan, Climate change, livelihood.

INTRODUCTION

Climate change is emerging as one of the most challenging problems facing the world in the 2_1^{st} century (O'Brien and Leichenko, 2000). Climate has already caused significant damage and threatens to bring even more serious consequences in the future and changes in the biosphere, biodiversity, and natural resources as a whole unfavorably affects human health and quality of life. Agriculture is one of the sectors most vulnerable to climate change impact. The impact is even stronger where agriculture is truly important for the daily subsistence and where adaptive capacity is low. Climate change impact, there is intra-sectoral and intersectional variation in vulnerability depending on location, adaptive capacity and other socioeconomic and environmental factors (McCarthy, 2001).

Climate change impact on agriculture is believed to be stronger in Sub-Saharan Africa (Kurukulasuriya & Mendelsohn, 2007). Within sub-Saharan Africa the effects of climate change on the dry lands of the Horn of Africa pose particular and difficult policy challenges. The arid climate together with the poverty faced by its inhabitants exacerbates the problems of development. However, the dry lands have under-exploited development potential and the dominant land use system – pastoralist – has unique adaptive characteristics that, together with the right enabling policies, suggest that climate change can be adapted to, and development can be achieved.

Most of East Africa's livestock wealth is kept by pastoralists in the dry lands. The bulk of the meat, milk and other livestock products consumed in the Horn of Africa come from pastoral areas in the dry lands. Global demand for meat and livestock products is rapidly increasing. Furthermore, grasslands store approximately 34% of the global

stock of CO2. Livelihood security in the region is strongly depending on rainfall distribution and land management practices among smallholder farmers. Over 95 % of the food producing sector is based on rain fed agriculture (Rockström, 2000).

1.1.Pastoralist in Sudan

Pastoral livelihood systems are based on three foundational pillars:

- Natural resources (water and pasture in dry lands);
- People (family and institutions); and
- Assets (livestock)

Understanding each of these pillars and the relationships between them is critical for promoting sustainable livelihoods and identifying ways of breaking cycles of negative social and environmental impacts. This also links closely to understanding the causes of vulnerability, which trigger maladaptive strategies among pastoralists in Sudan. Pastoral livelihoods are therefore a focus of UNEP's work in Sudan, in partnership with Tufts University, the International Institute for Environment and Development (IIED) and SOS Sahel Sudan, and supported by UK aid from the Department for International Development.

A critical element of pastoral livelihoods is mobility. In Sudan, a wide spectrum of mobility exists among pastoral groups, from entire families moving with their herds, to only a section of the family moving with livestock while a part remains settled (called transhumance), to entire families remaining settled, either hiring labour to move with the herd or having given up herding altogether. Mobility patterns also vary in different parts of the country.

Pastoralist livelihoods are flexible and adaptive and therefore fluid in the context of a changing environment. They will shift and adapt their systems of livestock production (transhumance, ranches, zero grazing) and diversify their livelihoods in response to changing contexts with varying implications for the environment and sustainable livelihoods. The project aims to understand some of the "push and pull" factors influencing this dynamic.

1.2 Pastoralist in Kordofan

1.2.1 Hawazma pastoralist community

Part of Sudan's Baggara tribe, are cattle herders who roam the area from the southern parts of North Kordofan to the southern borders of South Kordofan, a distance of about 300 kilometers. Through their nomadic movement, the Hawazma know the area, terrain, ethnic groups, local tribes, tribal cultures, ecosystems, climate, vegetation, existence of risks and diseases, and water resources better than any other inhabitants of the region. The term Baggara is a collective name applied to all cattle-herding tribes with Arab roots. Cattle herders from Nuba tribes are not called Baggara. Cattle herders of middle and eastern Sudan, although they are Arabic in roots, also they are not Baggara. The Baggara occupies a wide area, from Kordofan, Mid-Western Sudan, to Darfur in the far Western Sudan and extending to neighboring Chad. They are a collection of seven major tribes: Hawazma, Messiria Humr, Messiria Zurug, Rizeigat, Ta'isha, Habbaniya, Beni Halba, Awlad Himayd, and Beni Selam. All Baggara have close physical characteristics, costumes, dance, religion, food, and in general a common culture and way of life. ((Michael,1987).

MATERIALS AND METHODS

2.1.Study area

The study area is located in Southern Kordofan State is lies between latitudes 9° and 12° N, and longitudes 27° 25° and 32° E, with a total area of 135696 km² (Ibrahim, 2008). Administratively the state of South Kordofan after the emerging of Western Kordofan State according to WFP (2014) report: is divided into seventeen localities namely: Kadugli, Eldilling, Taloudi, Abugubeiha, Elgoz, Habila, Elabasyia, Ghadir, Heban, Um dorain, El boram, Abu Karshola, East Kadogli, Tadamun, Aleeri, Dallami and Rashad Fig (3.1).

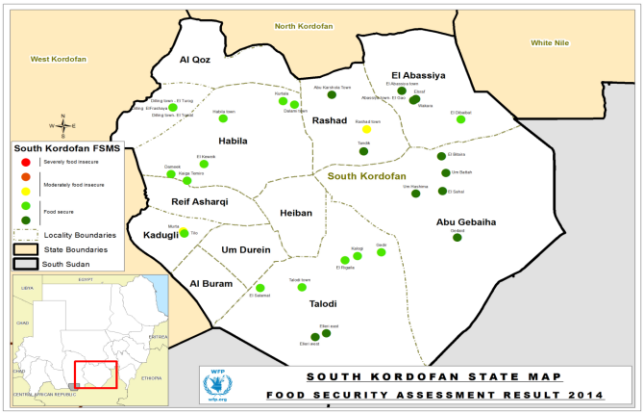

Figure 1. The map of South Kordofa State (Study Area).Source (WFP, 2014)

The area was classified according to Harrison and Jackson (1958) as sub- humid region. However, at present the range of isohyets put the state in the savannah zone. The rainy season extends from mid-May to mid-October and the annual rainfall ranges from 400-800 mm. Such climatic characteristics are providing for savannah landscape characterized by combination of trees and grasslands, which allow for grazing and seasonal rain-fed agriculture. Most of the rain is in the form of showers and thunderstorm types. Temperature is averaging 20º C during winter months (November-March), while during summer months (April-June), the average temperature is 35º C (S. M. D, 2007). The minimum mean temperature records 29º C while the maximum recorded was 38º C. The savannah climate is characterized by a dry period while the major amount of rains falls within three to four months. The greatest amount of rain fall is in July, August and September figures (3.2) and (3.3).

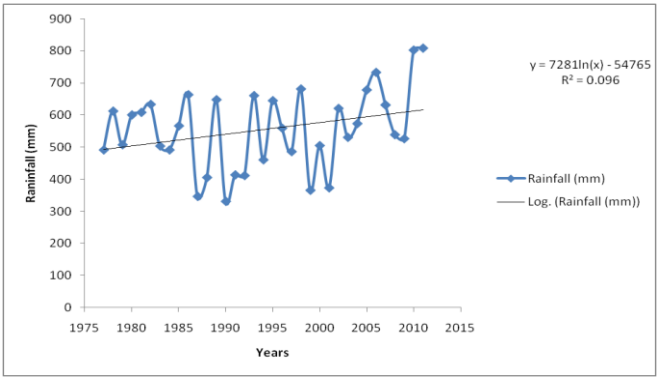

Figure 2. rain fall amount (mm) in the study area
Source: (Rashad Metrology Station (2014), processed by the Author)

Soils in the study area are shallow and usually variable with regards to physical characteristics and mineral contents. The geology of the area is characterized by basement complex formation, which is the oldest and most extensively found. The Nubian sandstone overlies the basement complex in the majority of the area (WSARP, 1982). Population in the Nuba Mountains is about 2.87 million inhabitants (census, 1993), however; the various Nuba people make up some 90% of the population of the area and the other 10% are Baggara (cattle herders) mainly Arabs (Sanjak, 2000). The Nuba villages are always built near valleys as they run from the hills out to the surrounding plains, because water is easier to find at such points and wells can be used all year long (Elsammani, 1986).
region are thorny.

2.2.Research Methodology

The study depends on two sources of data: Secondary data obtained from publications, scientific papers, and relevant references. Concerning the Primary data, collected via a questionnaire which designed, pre-tested and randomly distributed among the respondents mainly pastoralists.

2.2.1.Sample size

Concerning estimation and sample size determination for finite population, the following equation was used to determine the representative number of individuals according to (Ali, 2010).

$$n = \frac{n_0\ N}{n_0 + (N-1)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

Where:
n = sample size
n_0 = 96.04
N = number of population
The sample size for each route was calculated as follows:

1. Western route= $n = \frac{96.04(1300)}{96.04+(1300-1)}$ = 89
2. Middle route = $n = \frac{96.04(900)}{96.04+(900-1)}$ = 87
3. Eastern route = $n = \frac{96.04(1000)}{96.04+(1000-1)}$ = 88

The total sample size = **264**

2.2.2.Methods of Analysis

The collected data was entered in the computer and saved in special directory in the software of Statistical Package for Social Sciences (SPSS) program version 16 and later analyzed to develop the fitted models within the climate change adaptation and mitigation strategies.

2.2.2.1.Descriptive analysis approach

Was used to analyze the socio- economic characteristics of farmers. This included the calculation of the means,frequency distribution. The latter gives the number of observation falling into several ranges-values. Also the descriptive analysis approach is used to measure and identify the socio- economic characteristics and homogeneity of farmers that affect their level of efficiency such as gender, age, marital status, educational level and family size, credit size and timing.

2.2.2.2.Regression analysis

Regression analysis assumes that one variable is dependent upon another single, independent variables (simple regression) or multiple independent variables (Multiple Regression).

Regression analysis is employed by the method of ordinary least squares (OLS) to assess the relationship between the dependent variable and the independent variables (simple or multiple or regression) that affect it.
Multiple regression analysis was used, in which there is more than one independent variable that affect the dependent variable. It measures the effect of change in one variable while holding other variable constant (Ali, 2004).

The study used multiple regression models to measure the relationship between the dependent variable of crops yield and the independent variables such as crops variable seeds, labor, land and cultural operation for crops. (El Hussein, 2004).
The general equation of multiple regression models is specified as follows:

$$Y = b_{0+}b_1X_1 + b_2X_2 + b_3X_3 \ldots.\ b_nX_n + e$$

Where:
Y = the dependent variable
b_o= intercept (a constant of regression model)
x_1 ……x_n = independent variable
b_1….b_n= coefficients to be estimated.
The coefficient represents the change in the unit of dependent variable for a unit change in one independent variable, assuming other independent variable being constant.

RESULTS AND DISCUSSION

As described above, different pastoral groups inhabit South Kordofan or seasonally utilize its grazing resources. The bulk of livestock production takes place along the stock routes, for animals move from north to south in a synchronized pattern, with the onset of the rains or the dry season. The long-distance movement enables full

utilization of the available sources of grazing and watering. The stock routes have invited open competition between the nomads, the settled population and the mechanized farmers, and thus turned into major source of conflict in South Kordofan which has been further intensified in recent decades by the interplay of two important factors—drought and armed conflict, often resulting in changes in the traditional routes (UNDP, 2006).

Results of the analysis in table (1) revealed that the majority of the pastoralist (85.2%) replied they experienced Range change which demonstrates the degradation of Range due to climate change; therefore about 98.2% from them confirm the Range decreased, and only 1.8% experienced improvement in Range. The deterioration of Range carrying capacity has affected the staying period per location (Khata) table (2) which indicated that the majority of the respondents 96.9% confirm that among factors that determine period of staying was Range situation while others mentioned water availability, insects by 2.7%and 0.4% respectively, This result is in line with the results of (kandji , 2006) who found that climate change has constrained livestock mobility due to prolonged drought periods.

Table 1. Range changes according to nomad's perception in S.K. State

Items	Frequency	Percent
Range changed	225	85.2
pasture Range not changed	38	14.4
Total	263	99.6
Changed Deceased	218	98.2
Changed increased	7	1.8
Total	225	100.0

Table 2. Factors determining staying period of the nomads in S.K. State

Item	Frequency	Percentage
Range situation	253	96.9
Water availability	7	2.7
Insects	1	.4
Total	261	100.0

Climate change impact on livelihoods

Historically nomads depend mainly on livestock for their livelihood either through direct consumption of livestock and its product or through exchange of it and the products in the local markets. With recent climate changes and its impact on herding pastoralist was enforced to change the way of living and adopt other strategy for survival. The results in table (3) showed that most respondents (91.1%) indicated that livestock remain the main source for their livelihood with small portion of trade and crops selling. Crops cultivation was historically practiced by large portion of Baggara pastoralist in their original homeland (81.6), the results showed that more than have of the interviewed respondent (53.8%) cultivate crops during rainy season, while 46.2% of them didn't cultivate crops to meet food needs. The cultivated crops include sorghum, millet as food crops and sesame and groundnut as cash crops. According to the results there was an increase in sorghum and millet area and decrease in production in the last twenty years. And there was decrease in groundnuts and sesame area and production. The main purpose of crops cultivation to maintain the household food needs (68.6%) while others produce crops for both family needs and markets (31.4%). With regard to the pastoralist movements, there are predetermined routes for their movement demarcated by the government base on available land, grazing types and Range capacity. Results of the study revealed that most of the respondents 97% practiced open grazing system while 3% practiced closed one.

Pastoralist is considered as rational way resource use of the dry land resources, because pastoralists are expected to respond rational use and choose and profit from the climate variability. This allows for a vibrant and productive livelihood system in some of the harshest landscapes in the world (odi, 2009). From the result above pastoralist in Kordofan are still keeping animal with copping strategy either by involving in additional job or change of animal type that make them survive under the change climate conditions.

Table 3. Climate change impact on livelihoods

Income sources		Crop cultivation		Purpose of cultivation		Changes in grazing system		Range biodiversity		Change in route	
Animal	Others	Cultivate	Not cultivate	Family consumption	Market	opened	close	Improved	Deteriorated	Changed	Not changed
91.1	8.9	53.8	46.2	68.6	31.4	97	3	46.6	53.4	94.7	5.3

More than 90% of the respondents reported deterioration and changes in their traditional routes due to many reason including expansion of agriculture (49.8%) , war and conflict (27.4%) and decrease in Range productivity (17.7) , lack of water (2.5%) refers to unavailability of water, . also respondents have table (4).

Table 4. Factors determining staying period of the nomads in S.K. State

Item	Frequency	percentage
Range situation	253	96.9
Water availability	7	2.7
Insects	1	.4
Total	261	100.0

Regression analysis.

The general equation of multiple regression models is specified as follows:

$$Y = b_{0+}b_1X_1 + b_2X_2 + b_3X_3 .... b_nX_n + e$$

Where:

Y = the dependent variable

b_o= intercept (a constant of regression model)

x_1 ……x_n = independent variable

b_1….b_n= coefficients to be estimated.

The coefficient represents the change in the unit of dependent variable for a unit change in one independent variable, assuming other independent variable being constant.

The results of regression analysis table (5) showed that the coefficient of determination R^2 was 88% which means that the factor included in the model explain 88% of the change in size of herd owned by the pastoralist. The overall test of significance of the model was significant under 0.01%. The results indicated that the most positive influential factors to change the size of animal holding by pastoralist was the initial size of the herd before the climate change and the family size with significant effects at 1% and 10% respectively. The other factors include type of grazing, types of grasses and supplementary feeding has negative insignificant impact with coefficients of -18.120, – 6.6 and -2.996 respectively. While water availability has positive insignificant impact on herd size with coefficient of 3.055. This result insures the mobility of nomads from place to another depending on water and grass availability at the time considered as one of the adaptive mechanisms against climate change.

$$\hat{Y} = 1.299 + 1.028X_1 - 18.120X_2 - 6.632X_3 - 2.996X_4 + 3.055X_5 + 0.724X_6$$

Where:

Y = Initial herd size

b_o= intercept (a constant of regression model)

x_1 = Family size

x_2 = Type of grazing

x_3 =Type of grasses

x_4 = Supplementary feeding

x_5 = Availability of water sources

b_1….b_n= coefficients to be estimated.

Table 5. Regression analysis

	Coefficients B	T	Sig.
(Constant)	1.299	.024	.981
Family size	1.028	1.664	.098
Type of grazing	-18.120	-.712	.477
Type of grasses	-6.632	-.978	.330
Supplementary feeding	-2.996	-.068	.946
Availability of water sources	3.055	.412	.681
Initial herd size	.724	32.310	.000

R2 = 0.883 F=202.9 Sign. = 0.000

Conclusions and Recommendations

The results of regression analysis showed that the coefficient of determination R^2 was 88% which means that the factor included in the model explain 88% of the change in size of herd owned by the pastoralist. The overall test of significance of the model was significant under 0.01%. The results indicated the most positive influential factors to change the size of animal holding by pastoralist was the initial size of herd before the climate change and the family size with significant effects at 1% and 10% respectively.

Thus the study recommended the followings:

1- Improving the pasture in terms of quality through seed broad casting and quantity by organizing the grazing systems.
2- The study also recommend for diversification in the activities and the animal type to cope with the impacts of climate change.

The government policies should consider the traditions and customs of the pastoralists.

REFERENCES

Ali SM . 2004 . Impact of Tax Reforms on Agricultural Production and Exports: A Case Study of Cotton Crop in the Gezira Scheme. Ph.D. Thesis, University of Khartoum.

Brien OKL and Leichenko RM. 2000. Double exposure: Assessing the impacts of climate change within the context of economic globalization. Global Environmental Change, 10, 221-232.

El Hussein HA. 2004. Technical and economical efficiency of Cotton production in privatized Blue Nile Agricultural Schemes . Ph.D. Thesis, University of Khartoum.

Elsamani. 1986. Kordofan rehabilitation development strategy, No. I main report. Ministry of Finance and Economic Planing and UNDP, Khartoum, Sudan.

Harrison MN and Jackson JK. 1958. Ecological classification of the vegetation of the Sudan – Bull. Forestry Department, Khartoum, N. S. No. 2.

Hassan FA. 2002. Palaeoclimate, food and cultural change in Africa.vision, 2015.Socio- economic impacts.

Ibrahim MI. 2008. An Approach towards Sustainable Management of Umabdalla Natural Forest Reserve - Southern Kordofan State Sudan. MSc. Thesis submitted to University of Khartoum. Khartoum. Sudan.

Kurukulasuriya P and Mendelsohn R. 2007. Endogenous irrigation: the impact of climate change on farmers in Africa. World Bank Policy Research Working Paper 4278.

McCarthy J, Canziani O, Leary N, Dokken D and White K. 2001. Climate Change 2001: Impacts, Adaptation, and Vulnerability. Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge.

Michael BJ. 1987. Milk production and sales by the Hawazma (Baggara) of Sudan. Research in economic anthropology no.9, Greenwich, Conn.: JAI Press.

Rockström J. 2002. On-farm agro-hydrological analysis of the Sahelian yield crisis: Rainfall partitioning, soil nutrients, and water use efficiency of pearl millet. PhD-thesis in Natural Resources Management, Department of Systems Ecology, Stockholm University, Stockholm, Sweden.

Sanjak ME. 2000. The Contribution of Non Timber Forest Products to Local Livelihood in Southern Kordofan State, Sudan.

UN/ISDR. 2004. United Nations International Strategy for Disaster Reduction Living with Risk: A Global Review of Disaster Reduction Initiative 2004 version. United Nations, Geneva, p. 430.

UNDP/ DDC. 2008. Third African drought and adaptation forum, Ethiopia Addis Ababa, United Nations Development Programme Drylands Development Centre.

UNEP. 2007. Environmental Impact risk and opportunities assessment, united nation environment program.

USAID. 2013. Climate Change Vulnerability Assessment, West Africa

WFP. 2014. Food security monitoring, South Kordofan, Sudan, Draft report May 2014.

WSARP. 1982. West Sudan Agricultural Research Project Work Plan, Volume 111. Research Plan for Kadogli and other stations, WSARP Publication No. 15, Khartoum Sudan and Pullman, Washington, USA.