The Pastoral Community's Awareness of the Effects of Climate Change in Sennar Locality, Sudan

Samar, Gaffar Mohammed Elsiddig[1], Mohammed Ibrahim Abdelsalam*[2], Hala Ahmed Hassan[2], Kouthur Mohammedosman Abass Osman[2]

[1]Ministry of animals Resources, Range and Pastures General Directorate ', Khartoum, Sudan
[2]College of Forestry and Range Science ,Sudan University of science and Technology, Sudan
Corresponding Author Email: fdailmohammed@yahoo.com

Abstract— *The study was carried out in Sennar locality. The study aimed to raise the awareness of pastoralist communities about the phenomenon of climate change in the Sennar locality. Three villages were selected from the state namely Al Auar, Fangoga AlJabal and Almuhamadyea (Aulad Mahala), form the unit of Refi West Sennar, Sennar locality. The sample size was about 5% of the total population of pastoralists in the three villages. A questionnaire was designed according to the objectives of the study to collect information from the studied community. The data were analyzed using the statistical analysis program SPSS version 20 to find out the mean and significant differences. The study found that the majority of respondent (76.7%) said the income is appropriate income in previous. There were spread of undesirable plant species and invasive plants such as Senna obtucifolia (42.5%), Xanthium brazilicum (25.5%), and Ocimum basilicum (13.5%). Most of the respondents had adapted to use alternative management, there are about (50%) of respondents said buy feed, (25.4%) selling part of the herd, (12.3%) change animal type. The changes of the herd composition were due to the change in pastoral behavior and resulting to climate changes. There are many practices that help the pastoral communities to mitigate the impacts of climate change namely the change of grazing patterns, change the herds and diversifying their incomes. Education opportunities must be increased to raise the awareness of the pastoral communities of Sennar locality.*

Keyword— Climate change, rangelands, pastoralists, invasive species.

I. INTRODUCTION

The of Sudan contribute to the income and subsistence of a large sector of the population and in addition provide more than 80% of the total feed requirements of the national herd. Rangelands also host wildlife and play a vital role in soil and watershed protection, biological diversity, ecological balance, and environmental conservation [1]. Rangelands cover great parts of the world and are home of many people worldwide. Climate change is altering the global hydrologic cycle and is expected to have substantial and diverse effects on precipitation patterns in different regions [2]. It reduced water resources, changes in the primary productivity of crops, forage and rangeland, changes in the composition of plant varieties and quality of plant material; and reduced biodiversity, [3]. Pastoralism is a livestock production system that is based on extensive land use and often some form of herd mobility. Pastoralists and agro-pastoralists are one of the most climate-change-vulnerable groups on the globe, under increased climate variability, the need for diversification of income, a strategy

often (and increasingly) employed in pastoral areas, becomes ever more important [4]. Climate change and climate variability are driving fragile pastoral ecosystems into more vulnerable conditions [5]. Pastoral communities are considered among the communities most affected by climate change due to the fragility of the rangeland ecosystem. It is very important to determine the level of community awareness of climate change and its effects on natural resources and the pastoralist community to build on it in how to mitigate those effects.

II. MATERIALS AND METHODS

A. Study area

Sennar state Located in central Sudan between latitudes 12° 05⁻ to 14° 07⁻ N and longitudes 32° 58⁻ to 35° 42⁻ E, bordered by Gezira state to the north, White Nile State to the west, Gedaref state to the east, Blue Nile and Upper Nile state to the South, with an area of 40.680 square kilometers, [6]. The study focus on the pastoral communities which practice animal grazing in natural rangeland, to know their views on the impact of climate change on them, on the herds they raise, and on pastoral resources.

B. The sample unit size

Three villages were selected from the state namely Al Auar, Fangoga AlJabal and Almuhamadyea (Aulad Mahala), form the unit of refi West Sinnar, Sinnar locality, to represent the pastoral community under study, and 5% of the population was selected from these villages to represent the studied sample. The total population of the three villages was 1090 people (390, 700, and 300 person of Al Auar, Fangoga AlJabal and Almuhamadyea, respectively. The number of samples was **73** which represent more than 5% of the total population.

C. Questionnaire design

A questionnaire was designed according to the objectives of the study in order to collect information from the studied community. This questionnaire was judged by three expert reviewers, their opinions were taken, and the questionnaire was modified and printed in its final form.

D. Data analysis

The information collected by the questionnaire is coded and prepared for the purpose of analysis. The data were analyzed using the statistical analysis program SPSS in order to find out

the mean and significant differences, and then put them in tables and graphic forms in preparation for discussion.

III. RESULTS AND DISCUSSIONS

A. Gender of the respondents

There was the high significant difference at p < 0.0001 among the respondents according to gender. The results revealed that in table (1) the percentage of males was greater than females, reaching more than (71 %), while the percentage of females was only (28.8%). This may be attributed to responsibility of rearing animals by male more than female in Sennar locality.

TABLE 1. Gender of the respondents

Sex	Frequency	Percentage
Male	52	71.2
Female	21	28.8
Total	73	100
Sig	0.000 ***	

NS = insignificant (p>0.5). *= significant (<0.01). **= highly significant (p<0.001). ***= very highly significant (p<0.0001).

B. Age of respondents

There was the high significant difference at p < 0.0001 between the respondents according to age. It was found that in table (2) about (36%) of the respondents in the surveyed sample were within age group of (30- 40), this indicates that they depend on look after animals are the youth. Also, may be they able to go long distance in the study area.

TABLE 2. Age of respondents

Age	Frequency	Percentage
Less than 30	2	2.8
30-40	26	36.1
40-50	21	29.2
50-60	5	6.9
More than 60	18	25.0
Total	72	100.0
Sig	0.000***	

C. Education levels

There was the high significant difference at p < 0.0001 between the respondents according to education level. As shown in table (3) about (27%) of respondent in Sennar locality were illiterate, (22.2%) basic, (19.4%) primary (Khalwa), (18.1%) secondary and (11.1%) graduate. This could need more awareness to increase the education level. The absence of education has a negative impact on the awareness of pastoralist communities and their knowledge of mechanisms for adapting to climate change. Education is an important tool to enable communities to mitigate and adapt to the effect of climate change, [7].

TABLE 3. Education levels

Education level	Frequency	Percentage
Illiterate	20	27.8
Primary (Khalwa)	14	19.4
Basic	16	22.2
Secondary	13	18.1
Graduate	8	11.1
Post graduate	1	1.4
Total	72	100.0
Sig	0.000***	

D. Kind of animals

In the Figure (1) animal species in Sennar Locality were Sheep (37.2%), Goats (35.4%), Cattle (23%) and Camels (4.4%) currently. The results also show that the percentage of animals in the past was Goats (36%), Cattle (28%), Sheep (27.2%) and Camels (8.8%). This result indicates the change of animal species may be attributed to change in pattern of pastoralists as result to climate changes. In addition, this may be attributed to behavior of goat's grazer and browser in rangeland. Also, it is easy to rare sheep and could be pay it to sold necessary good if they need. Changing the type of animal in the pastoral communities is one of the ways to adapt to climate change and indicates awareness of this phenomenon.
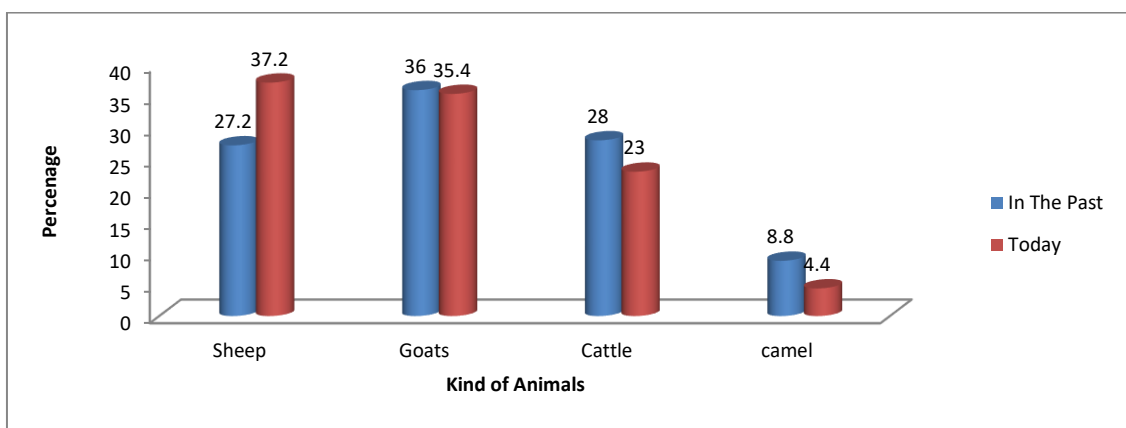

Fig. 1. Animal Species in Sennar Locality

E. Income of pastoralist

There was the high significant difference at p < 0.0001 between the respondents according to their income. According to table (4) shows that the incomes differ between previous years and currently. The majority of respondent (76.7%) they said appropriate income previously and (54.9%) mentioned appropriate currently. This may be attributed to rangeland condition previously is better than currently as result to climate

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change in the study area. The low level of income indicates the negative effects of climate change on the respondents.

TABLE 4. Income

Income	Previous		Current	
	Frequency	Percentage	Frequency	Percentage
Appropriate	56	76.7	39	54.9
Inappropriate	17	23.3	32	45.1
Total	73	100	71	100.0
Sig	0.000 ***			

F. Rainfall in Sennar Locality

From the Figure (2) shows the most of respondent (85.7%) said the rainfall increased, (11.6%) stable and (2.7%) degrease currently. Also, about (59%) said stable, (27%) decrease and (12.8%) increase in past years. This may be attributed to climate change in the study area. The rainy season is differing both spatially and temporally to that experienced in Sudan, [8].
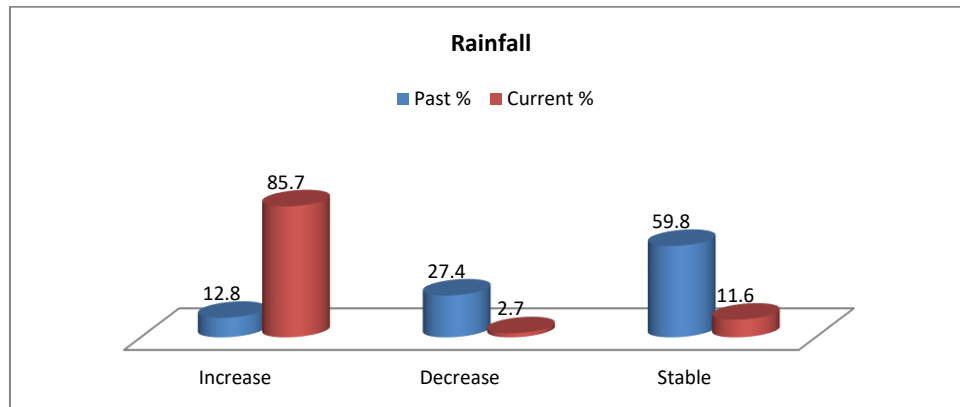

Fig. 2. Rainfall in Sennar Locality

G. Temperature

There was the high significant difference at $p < 0.0001$ between the respondents according to temperature in the study area. As illustrated in table (5) shows that (58.6%) and (50.8%) of the respondent said highest temperature in currently and previously respectively. This result indicated to effect of biotic and abiotic factors on range land in the study area.

TABLE 5. Temperature in Sennar locality

Temperature	Previously		Currently	
	Frequency	Percentage	Frequency	Percentage
High	33	50.8	41	58.6
Low	32	49.2	29	41.4
Total	63	100	70	100

H. Wind seasons

There was the high significant difference at $p < 0.0001$ between the respondents according to windy season and reason to wind. According to table (6) and (7) illustrated wind season and causes of increased wind in the study area. The result in Table (6) shows (66.7%) of respondent said the wind in the winter, (25%) said in the autumn and (8.3%) said in summer. As table (7) indicates reason to increase wind (55.8%) mentioned cut down trees and (37%) said weed removal. This may lead to negative impact on the rangeland such as deterioration and desertification of rangeland.

TABLE 6. The most wind seasons in Sennar locality

The windiest seasons	Frequency	Percentage
The autumn	18	25.0
The summer	6	8.3
Winter	48	66.7
Total	72	100
Sig	0.000***	

TABLE 7. Causes of increased wind in Sennar locality

Causes of increased wind	Frequency	Percentage
Cut down trees	70	58.8
Weed removal	44	37.0
Other	5	4.2
Total	119	100
Sig	0.000***	

I. Grazing patterns

There was the high significant difference at $p < 0.0001$ between the respondents according to grazing pattern. The result in table (8) showed that (60.3%) said they semi-sedentary, (27.4%) sedentary and (12.3%) nomadic. This could be due to fluctuation of rainfall and type of livestock rearing in Sennar locality. Grazing distribution has traditionally been defined as the pattern created by livestock grazing a pasture, [9]. The semi-sedentary grazing pattern with traditional agricultural practice is one of the traditional ways to mitigate the impact climate change, and it is an accumulation of local knowledge developing from community experiences.

TABLE 8. Grazing patterns in Sennar locality

Grazing style	Frequency	Percentage
Nomadic	9	12.3
Sedentary	20	27.4
Semi-sedentary	44	60.3
Total	73	100
Sig	0.000***	

J. Dominant plants

The result in table (9) show that the dominant plants in Sinnar locality was (22.2%), (*Senna obtucifolia*), (18.4%) (*Sonchus cornutu*), (10.5%) (*Ipomoea cordofana*), (8.8%), (*Indigofera spp*, (7.0%) (*Aristida spp*), (4.7%) (*Crotalaria thebaica*), (4.7%) (*Sparobolus marginatus*, (4.1%), (*Ocimum*

basilicum, (2.3%) *Xanthium brazilicum*, (1.8%) *Trianthema spp*, (1.8%) *Aristolochia bracteolate*, (1.2%) *Echiniachloa colona*, (1.2%) (*Frankenia hirsute*), (1.2%) (*Surghum sudaninsis*), (0.6%) (*Cenhrus ciliaris*), (0.6%) *Echinochloa phramidalis*, (0.6%) *Dactyloctenium gegyptium*. Biotic and abiotic filters can determine the distribution and relative abundances of species across space and time. Abiotic filters, such as environmental factors like climate, can dictate the distribution and relative abundance of species across biomes [10].

TABLE 9. Dominant Plants in Sinnar locality

Plant	Habit	Frequency	Percentage
Senna obtucifolia	Herb	38	22.2
Sonchus cornutu	Herb	32	18.7
Ipomoea cordofana	Herb	18	10.5
Indigofera spp	Herb	15	8.8
Aristida spp	Grass	12	7.0
Crotalaria thebaica	Herb	8	4.7
Sparobolus marginatus	Grass	8	4.7
Ocimum basilicum	Herb	7	4.1
Xanthium brazilicum	Herb	4	2.3
Trianthema spp	Herb	3	1.8
Aristolochia bracteolate	Grass	3	1.8
Echiniachloa colona	Grass	3	1.2
Frankenia hirsute	Herb	2	1.2
Surghum sudaninsis	Grass	2	1.2
Cenhrus ciliaris	Grass	1	0.6
Echinochloa phramidalis	Grass	1	0.6
Dactyloctenium gegyptium	Grass	1	0.6
Total		100	

K. Invasive Plants

Based on the results in table (10) show that the invasive plants in Sinnar locality was (42.5%) (*Senna obtucifolia*), (25.5%) (*Xanthium brazilicum*), (13.5%) *Ocimum basilicum*, (7.8%) (*Indigofera spp*), (4.9%) (*Senna alexanderina*), (2.1%) (*Striga spp*), (1.4%) (*Cenhrus ciliaris*), (0.7%) (*Aristida spp*), (0.7%) (*Tribulis terrstris*) and (0.7%) *Chloris virgate*. Spread undesirable plant species and invasive plant this indicates that negative impact of climate change on rangeland in the study area. The process of invasion is characterized by three phases, initial slow growth, exponential growth, and another period of slow growth [11].

TABLE 10. Invasive Plants in Sinnar locality

Plant	Habit	Frequency	Percentage
Senna obtucifolia	Herb	60	42.5
Xanthium brazilicum	Herb	36	25.5
Ocimum basilicum	Herb	19	13.5
Indigofera spp	Herb	11	7.8
Senna alexanderina	Herb	7	4.9
Striga spp	Herb	3	2.1
Cenhrus ciliaris	Grass	2	1.4
Aristida spp	Grass	1	0.7
Tribulis terrstris	Herb	1	0.7
Chloris virgate	Grass	1	0.7
Total		100	

L. Drought in Sennar locality

There was the high significant difference at $p < 0.0001$ between the respondents according to drought in Sennar locality. As seen in table (11) presents (32.9%), (25.7%), (17.1%), (15.7%) and (8.6%) of respondent reported that the area effect by drought especially in years (2015), (2013), (2016), (2017) and (2018). The differ amount of rainfall yearly this may lead to negative impact on plants and soil in Sennar locality. The impacts of drought are likely to become ever more severe because of development processes and population increases [12].

TABLE 11. The most drought years in Sennar locality

The Least rainy years	Frequency	Percentage
2015	23	32.9
2013	18	25.7
2016	12	17.1
2017	11	15.7
2018	6	8.6
Total	70	100
Sig	0.000***	

M. Reproduction of animals

There was the high significant difference at $p < 0.0001$ between the respondents according to reproductive of animals in the study area. As illustrated in table (12) about (68.5%) of respondents said the reproduction time for animal in Sennar locality was in autumn, (17.8%) said in winter and (13.7%) said in summer. This may be attributed to provide forage and water in autumn. Improvement in livestock productivity requires a comprehensive systems approach that addresses all constraints simultaneously i.e., nutrition, genetics, and health [13]. The pastoral communities had a good practice to adjust the reproductive time of their animals based on the availability of forage. This is an adaptive mechanism to prevent reproduction during periods of food scarcity. This practice is the result of cumulative awareness of the pastoral communities that it has acquired over time.

TABLE 12. Reproduction time for animals in Sennar locality

Reproduction time	Frequency	Percentage
Autumn	50	68.5
Winter	13	17.8
Summer	10	13.7
Total	73	100
Sig	0.000***	

N. Time the animals died in Sennar Locality

There was the high significant difference at $p < 0.0001$ between the respondents according to time died of animals in Sennar locality. As shown in table (13) the majority of pastoralists (95.7%) said the most of time the animals died was beginning of autumn and (4.3) said animals died in the middle of autumn. This may be attributed to week health of animals, shortage of forage, flood and flies in the beginning of autumn.

TABLE 13. Most of time the animals died in Sennar Locality

Most of time the animals died	Frequency	Percentage
Beginning of autumn	66	95.7
middle of autumn	3	4.3
Total	69	100
Sig	0.000***	

O. Alternative feeding

There was the high significant difference at p < 0.0001 between the respondents according to alternative feeding in Sennar locality. The results revealed that in table (14) the alternative about (50%) of respondents said buy feed, (25.4%) selling part of the herd, (12.3%) change animal type and (4.6%) said forage from natural pasture. A few low-quality forages can be fed to dry cows and replacement heifers, including small grain straw, sunflower and other [14].

TABLE 14. Alternative feeding in drought

Alternative feeding	Frequency	Percentage
Buy feed	66	50.8
Selling part of the herd	33	25.4
Change animal type	16	12.3
Forage from natural rangeland	6	4.6
Other	5	3.8
Change the source of income	4	3.1
Total	125	100
Sig	0.000***	

IV. CONCLUSION

Most of the pastoral communities were illiterates of about 27.8% in Sennar locality. The change of the herd composition was due to the change in pastoral behavior and resulting to the climate changes. The climate change strongly affects the plant and animals in rangeland of Sennar locality. The change of life patterns of pastoral communities in Sennar locality is due to changes in rainfall fluctuation and their behaviors. There is community awareness about the impacts of climate change in Sennar locality, which is represented in practices to mitigate these impacts, such as diversifying sources of income, and adjust the reproductive time of their animals. The study recommended to increase the opportunity of formal education and activate the pastoral extension to increase the environmental awareness and reduce the risks of climate change.

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