Impact of Climate Change and Vulnerability Assessment of Pastoralists Located in South Central Somalia Based on Income and Marital Status

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ABSTRACT

Recent changes in climate over the last three decades, have increased the incidences of severe droughts and floods in Somalia. Moreover, the frequent internal conflicts increases the level of vulnerability of its citizens' to climate change impacts. The UNDP puts at 5 million, the number of Somali people affected by drought incidences. Notably, factors such as income and marital status influence the vulnerability status of individuals in the region. This study assessed the vulnerability and impact of climate change of South Central Somali pastoralists based on income and marital status. The research was conducted through structured interviews and questionnaires and the sample size for the study was 400. The divorcees, were found to be the most vulnerable, compared to the married, singles and widows. On the other hand, the higher income earners were found to be less vulnerable to climate change impacts compared to the lower income earners. The findings demonstrate that marital status and income, play a key role in influencing the level of vulnerability of the individuals in the study area. The information can be used to formulate policies that will provide appropriate interventions to the most affected groups.

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1. INTRODUCTION

The current average land and ocean surface temperature is the highest to be ever experienced since 1400 globally [1]. Moreover, the surface temperature in Africa, has experienced a remarkable increase over the last century, along with the global surface temperature. Notably, the average increase in surface temperature in the 20th century was $0.7^{o}C$, and the value is higher compared to that of the 19th century, which was $0.5^{o}C$. In 1970 to 2010, the average increase in annual surface temperature ranged from 0.5 to $0.8^{o}C$ [2]. Furthermore, the scientists project that the average rise will be up to $6^{o}C$ by 2100 [3]. The number of cold days have significantly reduced, while those of warm days have considerably increased from 1961 to 2000 [4]. The changes in climate are consistent with those experienced in other parts of the world. However in Africa, the temperature rise is relatively higher compared to the other parts of the world [5]. Africa is adversely affected by the effects of climate change, and this is attributed to lack of appropriate disaster management measures and limited finances. Additionally, majority of the population, depend on rain for growth of agricultural food products [6]. Eastern Africa is one of the regions that these effects, particularly the prolonged drought seasons [7].

In Somalia, pastoralism and farming are the main sources of livelihood. The country has the highest number of pastoralists in Africa, and they account for at least 60 percent of the population, while the rest are farmers [8,9]. The two activities are greatly affected by climate change, since the pastoralists are compelled to content with massive loss of livestock, which escalates their vulnerability to food insecurity. Notably, they usually depend on the animal products for nutrition. Additionally, the periodic floods causes death of livestock and humans [9]. Moreover, the pastoralists in Somali, relied on the weather patterns in the past, to determine the mating seasons for their livestock and to migrate from one place to another in search of greener pastures for their livestock. The inconsistent weather patterns have interfered with the pastoralist calendar of both mating and migration, which has in turn affected their production [8].

In the last few decades, the number of extreme weather conditions have considerably increased in Somali. Previously, the country experienced at least one extreme climate event in each decade [10]. However, from 2001 to 2010, Somalia has encountered numerous alternating drought and floods occurrences. The incidences of drought have been found to increase the prevalence of conflict, starvation and under nutrition in Somali [9]. Drought has been recently declared a national disaster by the government of Somalia. This is because severe drought incidences has continued to affect the lives of approximately 5 million Somalis. Approximately 363, 000 are affected by malnutrition and 71,000 people are severely malnourished. The widespread impacts of climate change has made the citizens more vulnerable to diseases and abuse from terrorist networks [11]. There is therefore need to assess the vulnerability status of individuals in Somalia. The study assesed the vulnerability and impact of climate change of South Central Somali pastoralists based on income and marital status.

2. METHODOLOGY

2.1 Data Collection

The study area was the Galguduud and Gedo regions located in South Central Somali. The villages that were studied included: Abdilohow, Baar-Masare, Biritir, Britir, Kurtun, Mirkey, Oda, Qabri Alan, Shiidle, Surgudud, Una, Wagadey and Wareyle. The study was conducted using individual interviews, structured questionnaires and focus group discussions (FGD).The study sample size determination was carried out using the formula in equation 1 below. The unknown proportion was estimated by probability of (1-α) being no further than d from the true proportion.Where z is α/2 point of the normal distribution and ignoring the finite population correction to formula 2. Where, n- is the size of sample, Z- is the z-statistics for the desired level of confidence, p- is the estimate of expected proportion with the variable of interest in the population and e- is margin of error and at most case is 5%.

$$n = \frac{(N * (P * (1 - p))}{(N - 1) * (e^2 / z^2) + (p * (1 - p))} \quad (1)$$

$$n = \frac{z^2 * (p * (1 - p))}{e^2} \tag{2}$$

The confidence level was set at 95%, Z = 1.96, and e is 5%. Also, p is proportion that was estimated from the study. Since, p (1-p) is directly related to the required sample size, the maximum value for p (1-p) is when p = 0.5, because we were unable to find the prior proportion of the climate vulnerability of pastoralist community in the area rather than narrated description of the problem. Therefore, the sample size was calculated based on a worst case scenario when p = .50; then by putting these values into the above formula, we had a required sample size: around 385 i.e

$$n = \frac{1.96^2 * (0.5 * (1 - 0.5))}{0.05^2} = 384.65 = 385$$

Additionally, by assuming the response rate will be decreased due to cultural issue and movement from their original place/home we included additional 4% of total calculated sample size (385). i.e. 4/100 * 385 = 15.4 = 15 individuals, were added to the total sample and the final sample size of our survey was 400 individuals or households. This means that the sample size used for the survey was 400 individuals or house hold. The study included all individuals who were 19 years and above and were either pastoralists, agro-pastoralists and agronomists.

2.2 Vulnerability Assessment

The concept of vulnerability emanates from the extent of one's physical exposure to particular threats and it is primarily based socioeconomic status, exposure to hazards, access to natural resources, food insecurity and it evaluated using the risk factors and one's adaptive capacity. In this study, the integrated vulnerability approach was employed for the assessment. A list of indicators, which included direct dangers that are caused by climate change and factors that may worsen the impact was made and data collection was then carried out. The relationship between vulnerability status and income was then determined. The relationship between marital status and vulnerability status was then determined. Vulnerability was calculated using equation 3 below, while normalization of the values was done using the UNDP's Human Development Index (HDI) approach [12]. Formula 2 was used for positive relationship and

formula 3 was used for negative relationship. Where V is the vulnerability, I is the impact of climate change (exposure and sensitivity), AC is the adaptive capacity, Xij is the index value, Max{Xij} is the maximum value and Min{Xij} is the minimum value. The values variables that had a positive relationship with variability were normalised using the formula (2). The ones that had a negative relationship with variability, were calculated using formulae (3).

$$V = f(I - AC) \tag{3}$$

$$Xij = \frac{Xij - Min\{Xij\}}{Max\{Xij\} - Min\{Xij\}} \tag{4}$$

$$Yij = \frac{Max\{Xij\} - Xij}{Max\{Xij\} - Min\{Xij\}} \tag{5}$$

2.3 Data Analysis

The data collected was analysed using excel 13 and SPSS (statistical package for social science v.19 and 24). The data was analyzed by means of descriptive statistics technique chi-square. Test results were considered significant at the P=0.05. The association between the different indicators and the income of the individuals was then determined. The relationship between marital status and the different indicators was also determined and the overall vulnerability status by income and marital status was then calculated.

3. RESULTS

3.1 Main Problems Experienced in the Last 2 Years

3.1.1 Marital status

In general most of the individuals were affected by insufficient water as the main problem. The divorced were the most affected as 78% of them were affected compared to 65% of the married, 50% of the singles and 50% of the widows. The singles were highly affected by problem of insufficient food followed by the married. The singles who were affected were 40%, while the married were 24%. The singles were the most affected by drought, followed by the married. The problem of poor health of livestock mostly affected the divorced, while that of poor access to health care least affected all the individuals as shown in Fig. 1. The chi square test showed that there is a significant relationship between the marital status and those affected by the main problems within the last two years.
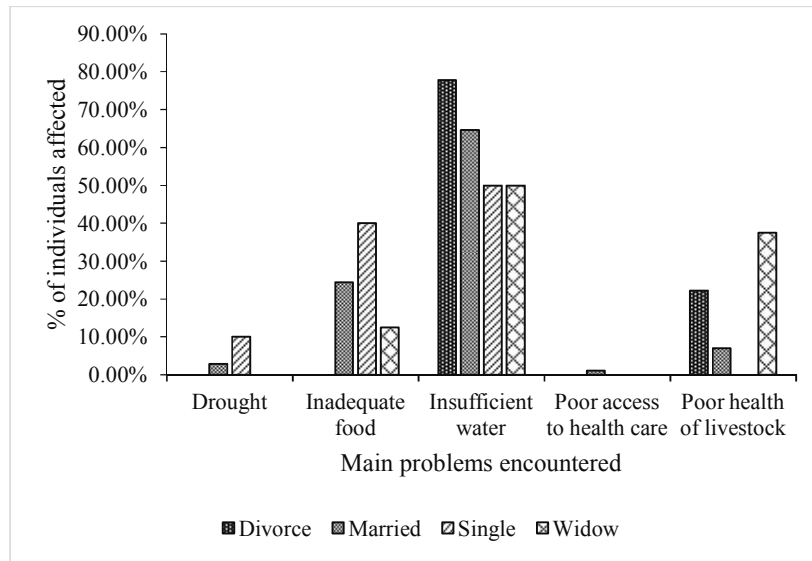
Fig. 1. Shows the main problems encountered and the % of individuals affected

3.1.2 Income

A high number of individuals from all the income brackets were found to be affected by the problem of insufficient water. The most affected income bracket were those that earned between from 2.5 - 3 million per annum (100%). Then, those who earned 1.0 to 1.5M, were 70%, while those that earned from 1.5001 to 2 M and from 2.0001 to 2.5 million were 61% and 53% respectively as shown in Fig. 2 below. Conversely, the problem of inadequate food,

highly affected individuals from lowest income bracket, which was 0.5-1M and 2.001-2.5M who were 20% and 33% respectively. Moreover, the problem of poor health of livestock was highest in the 2.0001 to 2.5 income bracket that had 13% of the individuals affected. The other age brackets that were affected were 1.5 to 2.0001 at 11% and 0.5 to 1M, where 7% of the individuals were affected. The chi square test showed that there was significant relationship at p=0.05 between the main problems encountered and the income of individuals in the study.
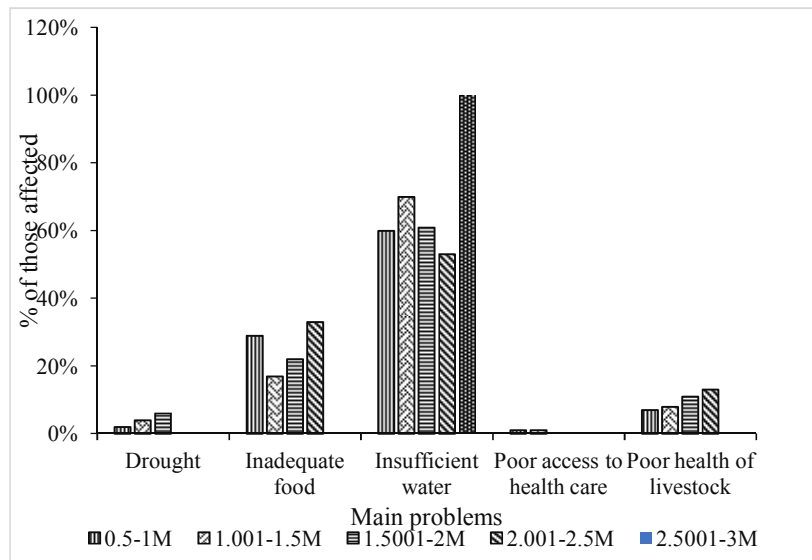

Fig. 2. Shows the main problems encountered and the % of individuals affected

3.2 Drought

3.2.1 Marital status

All the individuals were highly affected by drought in the year 2011. The widows were the most affected by the drought (88%), followed by the married who were 66% percent. The divorced and the widows were the least affected at 44% and 40% respectively. In 2014, many individuals were also affected. The divorced were the most affected, followed by the singles who were 33% and 30% respectively. In the year 2016, the singles were the most highly affected as they were 30% followed by the married who were 17%. The year when the individuals were least affected was 2010 as shown in Fig. 3. The drought shocks in the last 10 years were found to affect all the individuals. The divorced were the most affected by 5 shocks in 10 years. The singles and the married both had 10%, while the widows were not affected five times. The widows were the most affected by 4 shocks in a span of 10 years, followed by the divorced as they both had 38% and 22% respectively. The singles were the most affected in the two and three shocks category, while the married were the most affected in the 1 shock category. There was however no significant relationship that was found between the drought shocks in the last 10 years and the marital status.

3.2.2 Income

The drought shocks experienced by the individuals in the last 10 years were as shown in Fig. 4. The income bracket that had the highest number of individuals who experienced the drought shocks, was 1.5 to 2.0001, where 22%

of the individuals were affected. This was then followed by 1.0001M-1.5M and 1.0001M-1.5M, where 11% and 7% of the individuals were affected respectively. The 2.001M - 2.5M income bracket had the highest number of people who were infected by four shocks. The other income brackets that were affected were 0.5M-1M, 1.0001M-1.5M and 1.5001M-2M and the percentage affected was 19%, 18% and 17% respectively. Most of the individuals in the various income brackets were however not affected three times by the drought shocks, however a small percentage of 0.5M-1M, 1.0001M-1.5M and 1.5001M-2M, which were 9%, 18% and 6%.

The 2.5001M-3M age bracket was the most affected, while the least affected was the 0.5M-1M that both had 100% and 41% respectively. The group that had the most number of individuals affected once was the 0.5M-1M income bracket that had 24% of the individuals affected, while the least affected was 2.5001M-3M that had 0%. The year 2011, was when most individuals in all the income brackets experienced the worst drought. The most affected income bracket was 2.5001-3M, which registered 100%. The others that were affected were 0.5-1M, 1.001-1.5M and 1.5001-2M, where 63%, 68% and 20%. The other year where most individuals were affected was 2014 and the most affected income bracket was 2.001-2.5M (47%) while the least affected was 2.5001-3M (0%). In the year 2010, the least number of people were affected and they included: 0.5-1M and 1.001-1.5M that had 5% and 1% respectively as shown in Fig. 4 below. There was a significant relationship between the year of worst drought and income.
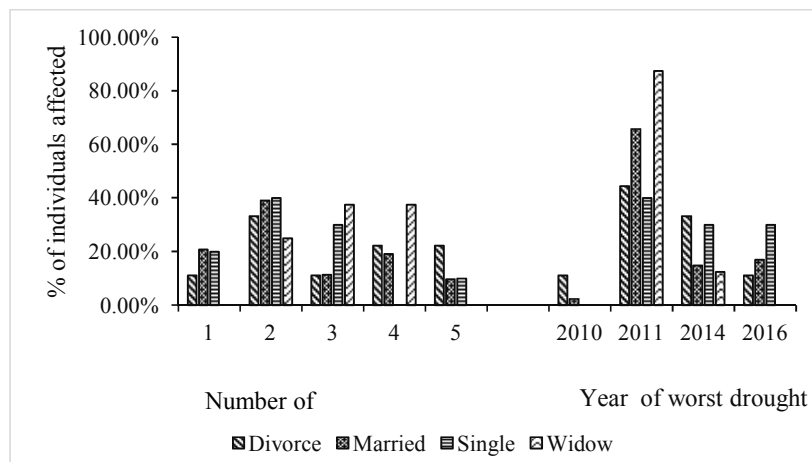

Fig. 3. Drought shocks and year of worst drought and the % of individuals affected
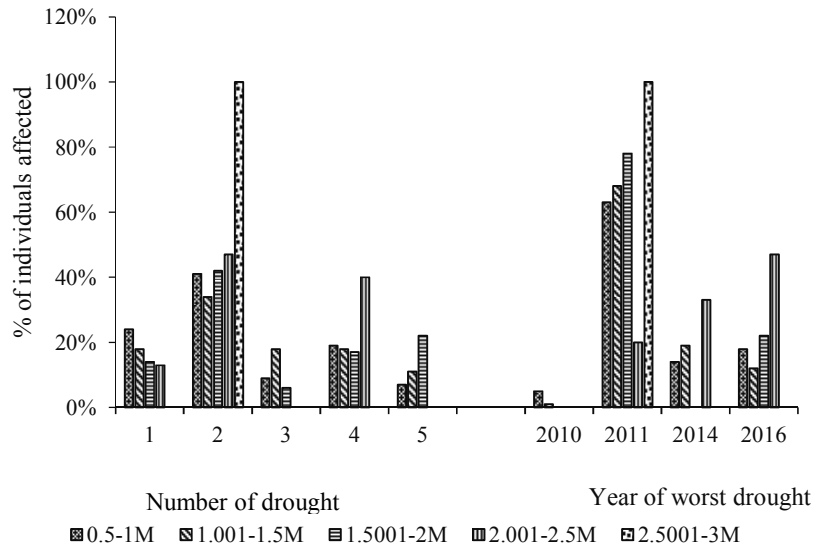
Fig. 4. Drought shocks and year of worst drought and the % of different income groups affected

3.3 Number of Animals Lost

3.3.1 Marital status

The individuals who lost the highest number of animals are the married and the widows, who each lost 6%. The group that lost the highest number of animals that were from 41 to 50, were the divorced, who were then followed by the singles. The least affected were the married and the widows. The individuals who lost the highest amount of cattle that were from 31 to 40, were 38% and they were widows and the individuals, who lost the highest number of 21 to 30 animals and were 21%. In the category of 11 to 20 animals, had the highest percentage of individuals who were affected. The most affected were the divorced at 56%, followed by the married at 40%, widows at 25% and finally the singles were the least affected at 20% as shown in Fig. 5.
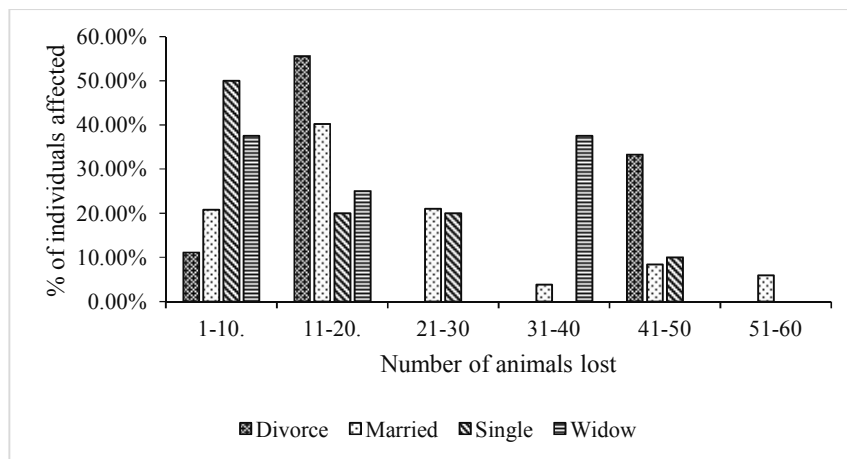

Fig. 5. Number of animals lost and the % of individuals affected

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3.3.2 Income

The number of animals lost were found to be higher in the lower income bracket. For instance in the 51 to 60 and 41 to 50 category of animals lost. The 2.5001-3M income bracket was not affected at all, while the other lower income brackets were affected. In the 30 to 40 category, 1.5001-2M income bracket was the most affected and the least affected was the 2.5001-3M. In the 11 to 20 animals lost, the 0.5-1M income bracket was the most affected and 1.001-1.5M. All the individuals who had the highest income, lost between 1 to 10 animals as shown in Table 2. The lower income brackets had a higher 8 of people who lost animals as shown in Fig. 6. There was a significant relationship between number of animals lost and the different income brackets at p=0.05.

3.4 Diseases

3.4.1 Marital status

In general most individuals were affected by malaria. The married had the highest number of people suffering from malaria and then the singles, the least affected were the widows. However no significant relationship was found between malaria and the different marital status. The proportion of those affected by diarrhoea in general was lower than those who were not affected in all the individuals. The married had the highest number of affected people and the divorced were least affected. Typhoid on the other hand, infected more individuals compared to diarrhoea as shown in Fig. 7. In all diseases there was no significant relationship that was

found between the diseases and the marital status.

3.4.2 Income

The malaria disease was generally found to affect all income groups, with a higher number of those affected being between 0.5 million to 1.0 million. The number of individuals in the high income bracket affected by the disease was low. However a higher proportion of the individuals in terms of percentage also suffered from the disease as shown in Fig. 8. The number of individuals affected by diarrhoea were generally lower than those affected by malaria and typhoid. The individuals from the lower income group were more affected by diarrhoea compared to those of the higher income group. The proportion of individuals affected by typhoid was found to be higher in the lower income groups compared to those in the higher income groups as shown in Fig. 8. A significant relationship was found at p=0.05 between the diseases and the income bracket.

3.5 Vulnerability

The vulnerability of the individuals was determined by marital status and found to be as shown below. The divorcees were found to be the most vulnerable followed by the married and widows as shown in Table 1. The 0.5-1M income group was found to be the most vulnerable followed by 1.001-1.5M, 1.501-2M and 2.001-2.5M. The least vulnerable income bracket was 2.5001-3M as shown in Table 2.
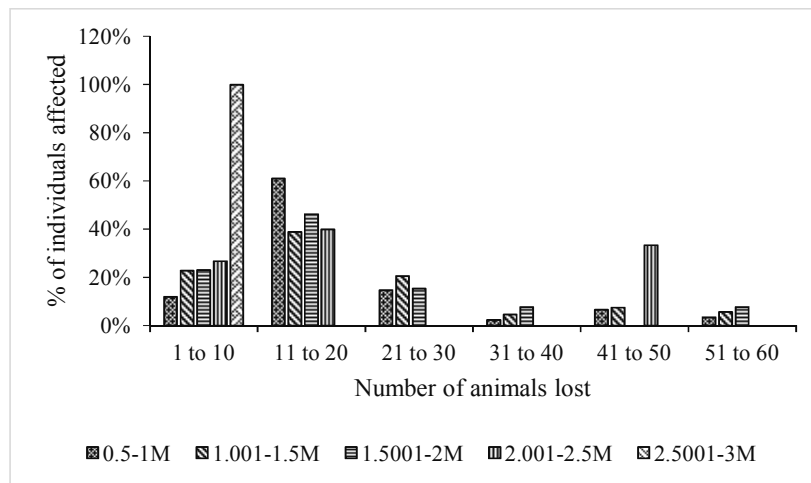

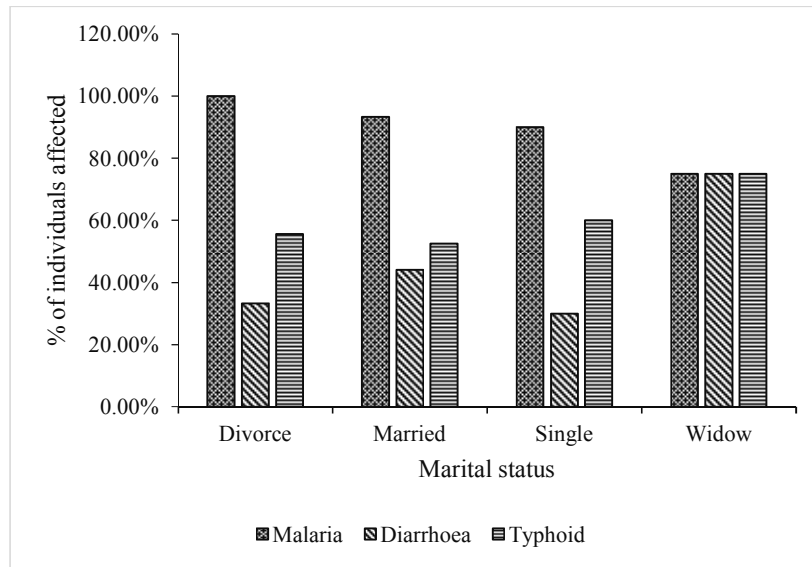**Fig. 6. Number of animals lost and the % of individuals affected**

Fig. 7. Disease and the % of individuals affected
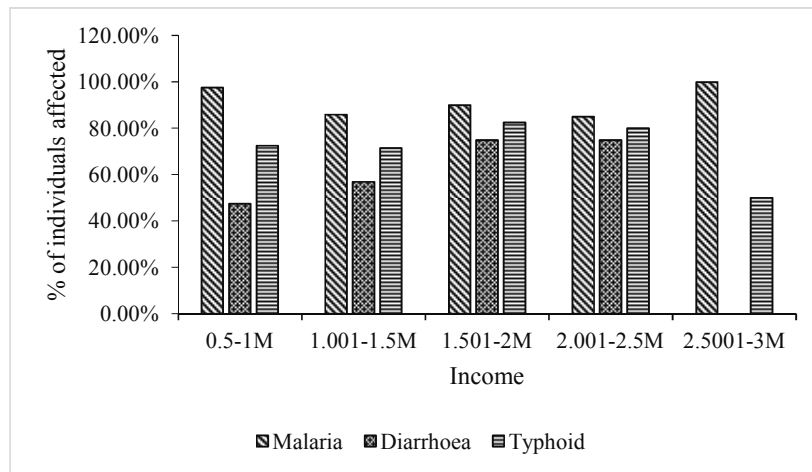
Fig. 8. Disease and the % of individuals affected in each income group

Table 1. Shows the vulnerability index by marital status

Indicators	Divorce	Married	Single	Widow	
Drought	0	0.03	0.1	0	+
Inadequate food	0	0.24	0.4	0.13	+
Insufficient water	0.78	0.65	0.5	0.5	+
Poor access to health care	0	0.01	0	0	+
Poor health of livestock	0.22	0.07	0	0.38	+
Drought shocks	0.48	0.36	0.29	0.42	+
diseases	0.73	0.63	0.6	0.67	+
Number of household	0.37	0.47	0.18	0.31	+
Number of animals lost	0.46	0.35	0.33	0.44	+
Number of animals	0.37	0.33	0.45	0.59	+
Home income	0.37	0.32	0.47	0.54	+
Vulnerability	2.29	1.82	1.16	1.72	

Table 1. Vulnerability index by income

	0.5-1M	1.001-1.5M	1.501-2M	2.001-2.5M	2.5001-3M
Drought	0.02	0.04	0.06	0.00	0.00
Inadequate food	0.29	0.17	0.22	0.33	0.00
Insufficient water	0.60	0.70	0.61	0.53	1.00
Poor access to health care	0.01	0.01	0.00	0.00	0.00
Poor health of livestock	0.07	0.08	0.11	0.13	0.00
Drought shocks	0.47	0.41	0.37	0.21	0.17
Diseases	0.73	0.71	0.83	0.80	0.50
Number of household	0.72	0.80	0.13	0.12	0.08
Number of animals lost	0.61	0.39	0.46	0.40	0.10
Number of animals	0.25	0.13	0.33	0.50	0.83
Vulnerability	3.27	3.19	2.45	2.02	1.02

4. DISCUSSION

4.1 Impact of Climate and Vulnerability by Income

4.1.1 Insufficient water

The problem of insufficient water was significantly higher in the divorcees compared to the other groups. This could be attributed to the fact that in the Somali culture and African culture in general, most divorced individuals are usually looked down upon especially women. In most African societies, the women are judged more harshly than men in most failed marriages and it is always viewed as their fault. The divorced women are therefore limited in terms of resources and may not freely mingle with the rest of the community. The task of looking for water in the Somali culture is mostly done by women and the fact that they may not be able to freely mingle with other women, affects them as they may not be able to know, where new water resources can be found. The women may also sometime have small children to take care, which also increases their vulnerability compared to the other groups. In the married group category both the man and the woman and even the big children are able to work. This means that as the women go in search of water, the men go to look for food and this reduces their vulnerability compared to the divorcees, except in instances where they have more number of small children and less resources [13]. The problem of insufficient water, was the major problem experienced by individuals from all the income brackets. The individuals from the 2.5001M-3M income bracket were the most affected, followed by those from 1.0001M-1.5M. This implies that the problem of insufficient water was not so much dependent on one's level of income, as the individuals who had the highest income bracket were the most affected.

4.1.2 Insufficient food

The problem of insufficient food was found to be relatively high in individuals from all the marital status. The singles were the most affected compared to the married individuals, widows and divorcees. This could be attributed to the fact that most singles are young individuals who were previously dependent on their parents and are not fully experienced in fending for themselves. The singles also may not work hard enough as their married counterparts, because they may not have children to take care of or household responsibilities. In the married group category, both the men and the women and even the big children are able to work and provide food for the family and this reduces their vulnerability compared to the singles [9]. The widows and divorcees were the least affected and this may be due to the fact that they may not have large household members as the married individuals. The problem of insufficient food was found to be higher in the 2.0001M - 2.5M and 0.5M-1M income bracket. The individuals in the highest income bracket were however not affected by problem of insufficient food. This could be attributed to the fact that the individuals in the higher income bracket, have a higher purchasing power and are therefore able to purchase more food even during drought period. The cost of food during drought is usually very high and most people from the lower income bracket may not be able to afford them [13]. This makes them more vulnerable to insufficient food, compared to those of a higher income bracket.

4.2 Drought

The divorcees were found to be most affected by drought shocks in the last 10 years as they had the highest number of individuals who experienced the 5 drought shocks. The singles

and the married on the other hand, were not highly affected by the drought shocks. The married on the other hand, were highly affected by one shock in the last 10 years. The divorcees were the most highly affected because they are culturally disadvantaged compared to the rest. The divorced women have to both look after their children and provide food for them. In the seasons of drought, they are highly affected because they are the only sole bread winners in the family in most cases. The year where most individuals were found to experience the worst drought shocks was in 2011. The most affected group was the widows followed by the married, the divorcees and then the singles. The widows may have been affected because just like divorcees, they may be the only sole bread winners in the family. The widows may have also had large household that had many small children. This means that in times of drought getting food that is enough to feed a large family may be a challenge.

The individuals who had the highest number of 5 drought shocks were those who were between the 1.5001M-2M income bracket followed by 1.0001M-1.5M and 0.5M-1M. This could be because the individuals fall in the lower and middle income range. Hence, they may have lacked the necessary resources required to minimize the number of shocks. Moreover, the higher income brackets were not affected by 5 drought shocks. Notably, the 2.001M - 2.5M were adversely affected by the four drought shocks, followed by 0.5M-1M. Primarily, the lower income brackets were highly affected by the three drought shocks. However, the high income brackets had high proportion of 1 and 2 drought shocks. In 2011, the highest income bracket was most affected but not in the other years. This means that they may have used their resources to cushion them from the detrimental effects of droughts. The other lower income brackets were however affected in all the other years, where the least effect was experienced in 2010. The probable reason could be they lacked resources that they can use to prevent the drought shocks. The findings imply that the individuals of the lower income bracket lack adequate resources to cushion them against drought shocks.

4.3 Number of Animals Lost

The married and the widows had the highest number of individuals who lost between 51-60 animals. The widows on the other hand were most affected by those who lost between 41-50

animals during the drought periods. The high number of animals lost may be attributed to the fact that during drought. There is less pasture and water available to feed the animals and the individuals with high number of cattle are usually more affected compared to those with less cattle as they require more water and pasture to feed their livestock and this eventually leads to death of the animals as getting pasture and water that is enough for the animals s usually a great challenge. The singles had the highest percent of those who lost the least number of animals, which was 0 to 10. This may be attributed to the fact that most singles only have a few ears of working experience and would therefore not have as many animals as their married counterparts, except for the few cases of inheritance [14].

The lower income brackets were found to be affected by loss of more number of animals compared to the higher income group. The 0.5-1M, 1.001-1.5M and 1.5001-2M had individuals who lost between 51 to 60 animals, while 2.001-2.5M and 2.5001-3M, were not affected. The individuals in the 2.5001-3M income bracket lost the least amount of animals, which were from 1 to 10. This may be attributed to the fact that individuals who have higher income are able to purchase more water and pasture for their animals, which increases their chances of survival [13]. There was a significant relationship between the income bracket and number of animals lost. The findings of the study, therefore imply that the income an individual earns in the study area has an effect on the number of animals lost. The higher the income, the less the number of animals lost.

4.4 Diseases

The malaria disease was found to affect most individuals and the divorcees were the most affected as all of them had malaria. The married, singles and widows also had a high number of people, who had the malaria disease. The disease was however not found to have significant relationship with marital status. Diarrhoea on the other hand, was found to affect the widows most as a high proportion of them had diarrhoea in the last 3 months. The divorcees, singles and the married were also affected but the number of those affected was less than those that were not affected. Typhoid on the other hand, was found to be highest in widows and divorces. The married the highest number of people who were affected because a greater proportion of the population consists of

the married individuals. Generally malaria was found to affect all the income brackets however the individuals of the lower income bracket were most affected. Typhoid on the other hand, was also found to affect more people compared to diarrhoea, however a higher number of individuals affected, were those of the lower income bracket. The findings of the study therefore show that the amount of income an individual earns, influences the vulnerability of an individual to diseases.

4.5 Vulnerability by Income

The divorcees were the most vulnerable as they had the highest value of vulnerability. The married and the widows had close values and they came in second and third respectively. Conversly, the singles were the least vulnerable. The probable reason for the high vulnerability in divorcees is that they have the responsibility of taking care of their children and providing food and basic needs for them. Conversely, the married individuals have defined roles, whereby, the wives take care of the children and attend to hose chores, while the husbands provide food. Furthermore, the divorcees especially females are shunned in most African communities, hence they lack assistance from family. Additionally, the divorcees may have a high number of dependents such as children to cater for on their own. The married and the widows on the other hand, usually have many family members who can assist in bringing in income that can help mitigate the adverse effects of climate change, however since they also have responsibilities and children to fend for, hence, their vulnerability is higher compared to that of singles who mostly have less responsibilities [14]. The 0.5-1M income group was found to be the most vulnerable followed by 1.001-1.5M, 1.501-2M and 2.001-2.5M. The least vulnerable income bracket was 2.5001-3M. The findings imply that the vulnerability of the individuals to climate change is highly dependent on income. The individuals that have low income are likely to be more vulnerable compared to those who have high income.

5. CONCLUSION

The findings revealed that marital status influenced the level of vulnerability of individuals in the study area. The divorcees were found to be more vulnerable compared to the married, singles and widows. This implies that the non-governmental organizations and the government should prioritize the widows when administering

help to individuals affected by effects of climate change in Somali. Additionally, the low income earners should be targeted since they have are the most vulnerable compared to the high income earners. Moreover, individuals who are both low income earners and widows are more vulnerable to effects of climate change and they should targeted during financial aids. Future studies should explore the influence of the different adaptive measures provided by the government and non-governmental organizations on the vulnerability index of the most vulnerable groups.

ETHICAL APPROVAL

A verbal informed consent was obtained from individuals, before conducting the interviews.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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