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The Impact of Climate Change on Livestock Production in Swaziland: The case of Mpolonjeni Area Development Programme

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Abstract

This study sought to investigate the impact of climate change on livestock production at the Mpolonjeni Area Development Programme in Swaziland. Primary data were collected using an interview schedule from 323 sampled households. Climate data were collected from the Swaziland Meteorology Department and Livestock data were collected from the Ministry of Agriculture. Perceptions of households and climate data were used to establish climate patterns in Mpolonjeni Area Development Programme. The Recardian regression model and descriptive statistics were used to establish the impact of climate change on livestock production. A total of 99.4% of the respondents suggested that temperatures were increasing whilst 98% felt that rainfall patterns were erratic. About 95% of the respondents have experienced drought at some point in time. Results of the Ricardian model showed that goats net revenue was sensitive to winter temperature, winter temperature squared, winter rainfall

and winter rainfall squared. The study concludes that climate change impacts negatively on livestock production and thus livestock owners need touseclimate change adaptation strategies, adapt especially when it comes to drinking water sources for the animals. In case of poor rainfall, farmers need to provide their animals with drinking water. Government should assist livestock farmers with reliable water sources such as canals and dams.

Keywords: Impact, Climate Change, Livestock Production, Recardian Regression

1. Introduction

According to Thompson (2013) agriculture is the backbone of Swaziland's economy and a major source of employment for rural households with more than 70% of the population relying on this sector for their income. The diverse agricultural activities that take place in the country include sugarcane production, citrus fruits, maize and other cereal crops, cotton, forestry and livestock production. In the year 2010, agriculture contributed an estimated 7.4% to the country's GDP (Thompson, 2013). Swaziland's agricultural sector is divided into two sub-sectors: formal and informal or traditional agriculture. Informal agriculture is practiced under the Swazi Nation Land (SNL) tenure system where land is acquired in terms of traditional law and custom. Informal agriculture is mainly carried out for subsistence purposes although farmers are encouraged to engage in commercial farming. Traditional agriculture farmers produce mainly maize, sorghum, cotton, tobacco, goats, poultry, cattle, pigs, sheep and legumes such as beans and groundnuts. Assisted by the large estates and the Sugar Association, there has been an increase in the number of small cane growers who produce commercially on SNL. The formal agriculture sub-sector embraces the large sugar and citrus estates, forestry, beef and poultry production, dairy farming, fruit and vegetable production (Thompson, 2013). According to Oseni and Masarirambi (2011) the agricultural system in the country has declined over the years due to rainfall variability and drought, subsequently leading to vulnerability erratic weather and food insecurity. Manyatsi, Mhazo and Masarirambi (2010) reported that communities perceived inadequate food supply, poor crop yields and poor performance of pastures as the main effects of climate variability and climate change in the country in Swaziland.

Thompson (2013) reported that the livestock subsector accounts for about 14% of agricultural output and 1% of total GDP. Swaziland has a relatively high unexploited potential of improving livestock production especially on Swazi Nation Land where 83% of the country's livestock is reared. FANRPAN (2011) reports that livestock is a very important livelihood asset for the rural people in Swaziland. People derive their livelihood from livestock in the form of food, income, organic fertilizer, as a form of investment, power for ploughing their fields and for traditional ceremonies such as weddings. Unfortunately, different studies showed that agriculture is sensitive to climate change in Swaziland (Manyatsi, 2010; Manyatsi et al. 2010; Sibanda, Kureya & Chipfupa, 2008). Climate change affects natural resources (such as water sources, land and pastures), biodiversity and livestock health (Thornton, 2010). This has a direct effect on livestock production and livestock systems and as such it is not good for the livelihood of the people especially those residing in the rural areas as it will worsen their poverty status making them more vulnerable to all sorts of external shocks such as diseases and

drought. However, the extent of the impact of climate change on livestock production in rural Swaziland has not been ascertained. This study therefore, was designed to reduce the information gap that exists on the impact of climate change on livestock production at Mpolonjeni Area Development Programme. The study sought to assess climate change patterns at Mpolonjeni Area Development Programme, and to assess the impact of climate change on cattle and goat production at Mpolonjeni Area Development Programme.

2. Literature Review

2.1 Global Impacts of Climate Change

The intergovernmental Panel on Climate Change (IPCC) (2007) defines climate change as the change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period. Climate change effects include among other things i.e. sea level rise, changes in the intensity, timing and spatial distribution of precipitation, changes in temperature and the frequency, intensity and duration of extreme climate events such as droughts, floods, and tropical storms. The issue of climate change and its impacts on livelihood has been well documented by different researchers globally (Deressa, Hassan & Ringler, 2009; Omari, 2010; Thornton, 2010; UNFCCC, 2007), thus a number of forums such as the Conference of Parties (COP) have been created where delegates from all over the World sit down and share ideas on climate change and its effects. The IPCC (2007) asserts that climate change will have severe effects on the environment, especially water availability, agriculture and food security, human health, and biodiversity. Since the IPCC's first report in 1990, assessed temperature projections have suggested global average temperature is increased between 0.15 and 0.3^{o}C per decade. Greenhouse gas emission could be raised globally 25–90% by 2030 and temperatures could be increased by 3% by the year 2050 (IPCC, 2007). It is further predicted that even with a small temperature rise of 1-2.5%, the consequences could still be severe, exerting far-reaching impacts on the livelihood of many people. Africa is already a continent under pressure from climate stresses and is highly vulnerable to the impacts of climate change. It is estimated that one third of African people already live in drought-prone areas and that 220 million are exposed to drought each year. African countries are prone to greater impacts of climate change and variability partly because they often lack adaptive capacity. Africa is particularly vulnerable to climate change because a large proportion of the population resides in rural areas and is heavily dependent on climate-sensitive livelihoods such as agriculture, and on water and non-timber forest products. Many factors are reported to be contributing to the current impacts of climate variability in Africa and they include poverty, illiteracy and lack of skills, weak institutions, limited infrastructure, lack of technology and information, low levels of primary education and health care, poor access to resources, low management capabilities and armed conflicts. Over exploitation of land resources including forests, increase in population, desertification and land degradation are said to be posing some additional threat (UNDP, 2007). According to the FAO (2007), in Africa by 2020, between 75 and 250 million people are projected to be exposed to increased water stress due to climate change. In some countries yields from rain-fed agriculture could be reduced by up to 50%. According to UNFCCC (2007), agricultural production including access to food in many African countries is severely compromised and this would

further adversely affect food security and exacerbate malnutrition. Under climate change much agricultural land will be lost, with shorter growing seasons and lower yields. Climate change will cause a general decline in most of the subsistence crops such as sorghum in Sudan, Ethiopia, Eritrea and Zambia; maize in Ghana; millet in Sudan; and groundnuts in Gambia (UNFCCC, 2007). Towards the end of the 21st century, projected sea level rise will affect low lying coastal areas with large populations with the cost of adaptation estimated at 5 to 10% of GDP. According to UNFCCC (2007) coastal infrastructure in 30% of Africa's coastal countries, including the Gulf of Guinea, Senegal, Gambia, Egypt, and along the East-Southern African coast, is at risk of partial or complete inundation due to accelerated sea level rise. Future sea level rise is also said to be threatening lagoons and mangrove forests of both eastern and western Africa, and is likely to impact urban centres and ports, such as Cape Town, Maputo, and Dar Es-Salaam. Africa is vulnerable to a number of climate sensitive diseases including malaria, tuberculosis and diarrhoea (UNFCCC, 2007). It is further reported that future climate variability will also interact with other stresses and vulnerabilities such as HIV and AIDS resulting in increased susceptibility and risk to infectious diseases such as cholera and diarrhoea and malnutrition for adults and children (WHO, 2006).

2.2 Climate Change Impacts in Swaziland

As reported by IPCC (2007), Africa is very vulnerable to climate change and Swaziland is not immune to this. The sectors that are sensitive to climate change and climate variability in Swaziland include water resources, agriculture and food security, natural resources and biodiversity, and health (Manyatsi, et al. 2010). Over the years Swaziland, has suffered from many climate change impacts such as droughts, change in rainfall patterns and increasing temperatures. For instance, in 1984, there was Cyclone Domonia which affected more than 400 000 people and caused damage worth US $54 million. Houses and fields were flooded and washed away and a number of people drowned. Infrastructure such as roads, electricity and telephone lines were damaged (Government of Swaziland, 2008). In January 2000, the country was severely affected by torrential rains that led to flooding with an estimated 21% of the population affected (IFRC, 2000). It is further concluded by Manyatsi et al. (2010) that Swaziland, just like many countries in the region is experiencing a number of natural disasters that include drought, occasional floods, cyclones, hailstorms, windstorms and wildfires, and that about 40% of the country's population is facing acute food and water shortage due to prevailing drought. Climate change will have a significant effect on agriculture in Swaziland, as predictions are that temperatures will increase by as much as 2.5^{o}C by 2050 and precipitation will decrease by as much as 100mm (Manyatsi et al., 2010). Recently, it was reported in one of the daily newspapers that a heavy storm swept through the Shiselweni and Lubombo regions. In the Shiselweni region the damage was estimated at over a million Emalangeni with over 25 homesteads hit, maize crop fields were damaged, cars and public transport were damaged and stock in shops drenched in water after roof tops were blown away. Apart from cattle that were struck by lightning, homes and schools' roofs were blown off in the Lubombo region (Vilakati, 2012).

2.3 Livestock Production and Climate Change

Literature is pointing to the fact that climate change does affect livestock production and livestock systems. For instance, Thornton (2010) concludes that the biggest impacts of climate change are going to be seen in livestock and mixed systems in developing countries where people are already highly vulnerable. The need to adapt to climate change and to mitigate greenhouse emissions will undoubtedly add to the costs of production in different places and the projected growth in bio-fuels may have substantial additional impacts on competition for land and on food security. According to Naqvi and Sejian (2011) due to the fact that the livestock production system is sensitive to climate change and at the same time itself a contributor to the phenomenon, climate change has the potential to be an increasingly formidable challenge to the development of the livestock sector, and that responding to the challenge of climate change requires formulation of appropriate adaptation and mitigation options for the sector. The projected trend of population growth indicates that livestock population will increase tremendously over the next few years and hence creating a database for GHG inventory are important indicators for studying the future impacts of livestock to climate change. In pastoral and agro-pastoral systems, livestock are key assets for people, providing multiple economic, social, and risk management functions. The impacts that climate change will bring about are expected to exacerbate the vulnerability of livestock systems and to reinforce existing factors that are simultaneously affecting livestock production systems such as rapid population and economic growth, increased demand for food (including livestock) and products, increased conflict over scarce resources (i.e. land tenure, water, bio fuels etc). For rural communities, losing livestock assets might lead to the collapse into chronic poverty with long-term effects on their livelihood (IFAD, 2011).

According to the FAO (2008) among the direct effects of climate change are high temperatures and changes in rainfall patterns, translating in an increased spread of existing vector-borne diseases and macro parasites of animals as well as the emergence and spread of new diseases. In some areas, climate change may also cause new transmission models and these effects will be felt by both developed and developing countries, but developing countries will be most impacted because of their lack of resources, knowledge, veterinarian and extension services and research technology development. Some of the indirect effects will be brought about by changes in feed resources linked to the carrying capacity of rangelands, the buffering abilities of ecosystems, increased desertification processes, increased scarcity of water resources, lower production of grain and so on.

Findings from similar studies showed that climate change has an impact on livestock production. For instance, Abate (2009) found that drought and delay in the onset of rain led to poor regeneration of grass, water shortage and heat stress on livestock. It further reports that the drought and delay of rainfall led to increased mortality of livestock, vulnerability to diseases and physical deterioration due to long distance travel for water and pastures. Digambar (2011) reported that as a result of severe drought, there was direct impact on the growth of palatable grass species and that regeneration of fodder species in pasture and forest fodder is decreasing because of less rainfall leading to a shortage in diversity and quality of livestock fodder. According to Digambar (2011), this has led to a decrease in livestock population which has

further affected production of milk, milk products and meat. The drought also affected livestock by drying wetlands, pasture land, water resources, streams and decreasing availability of drinking water for livestock. Temperature increase led to outbreak of new born diseases and scarcity of fodder led to change in livestock pattern (Digambar, 2011).

3. Methodology

3.1 Study Design

The study was both qualitative and quantitative in that it used peoples' perceptions and empirical data to establish the impact of climate change on livestock production.

3.2 Study Area

The study was carried out at Mpolonjeni Area Development Programme (ADP). The ADP is located in the central east of Swaziland in the Lubombo region and it is about 105 kilometres from Mbabane. Five communities are covered by the programme, namely: Ngcina, Mpolonjeni, Shoba, Ndzangu, and Langa. According to FANRPAN (2011), the Mpolonjeni Area Development Programme has 3212 households with an estimated population of 24 000. The Mpolonjeni Area Development Programme falls within the Lowveld and has high summer temperatures, with mean temperature ranging between 17 – 27^{o}C. On an average 600 – 750mm of rainfall were received annually. It altitude was 200 – 500 metres above sea level. Other characteristics of the Lowveld include winter frosts and fertile soils. The area is prone to drought and climate variability (Kureya, Chipfupa & Nxumalo, 2009). Households rely on raising crops such as maize, beans, ground nuts, cotton, sweet potato, jugo beans, potatoes, sorghum, cowpeas, and pumpkins for livelihood. However, due to high temperatures and less rainfall, yields, in particular maize are poor in most years. As a result, the Lubombo region has consistently received food aid over the years. They also rear livestock such as cattle, goats, poultry, pigs and sheep (Kureya et al., 2009). Figure 1 is the map of Swaziland with the shaded area showing the location of Mpolonjeni Area Development Programme.

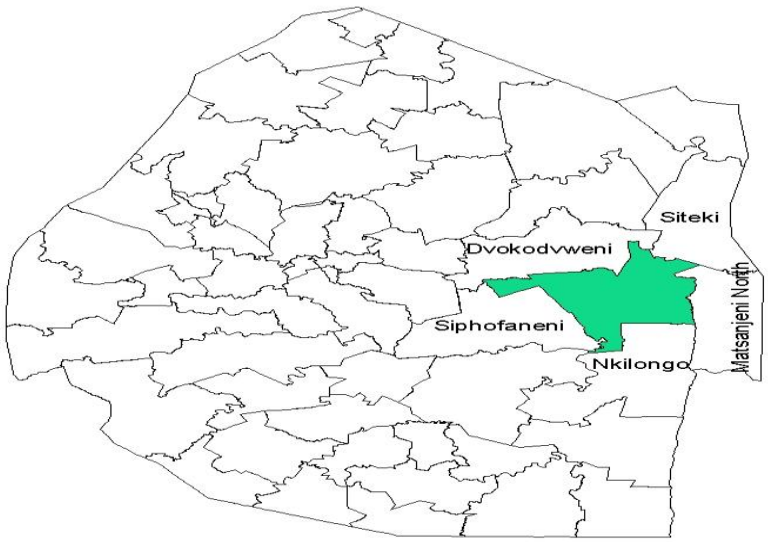

Figure 1. Map of Swaziland showing location of Mpolonjeni ADP

3.3 *Sampling Procedure and Sample Size*

A stratified sampling procedure was used to come up with the required sample. The master table from the census data collected by FANRPAN in 2009 at Mpolonjeni Area Development Programme was used as the sampling frame. The 3212 households were divided according to the five communities under Mpolonjeni ADP: Ngcina, Mpolonjeni, Shoba, Ndzangu and Langa. Thereafter, ten percent of households from each of the chiefdoms were randomly sampled to come up with the study sample of 350 households: 179 households were sampled from Kalanga, 36 were sampled from Kandzangu, 49 from Kashoba, 69 from Mpolonjeni and 17 from Ngcina. However, due to inability to trace some of the households, only 323 households were studied. This was because some of the households did not own livestock. Table 1 shows the sampled households from each of the five communities.

Table 1. Sampled Households from each Community

Commuinity	Number of households	Sampled households	%
Mpolonjeni	618	69	11.1
Ngcina	157	17	10.8
Kashoba	441	49	11.8
Kandzangu	351	36	10.2
Kalanga	1645	179	10.8
Total	3212	350	10.9

3.4 Data Collection

Primary data on climate change patterns and climate change impacts on livestock were collected through a personal interview from the 323 sampled households using an interview schedule. The data were collected between January, 2013 and March, 2013. Temperature and rainfall data from 1980 to 2012 recorded at Big Bend weather station were also solicited from the Swaziland Meteorology Department. Big Bend weather station was selected because it lies in the same agro-ecological zone and it is within the study area. Livestock data on cattle and goat populations from 1983 to 2011 were gathered from the Ministry of Agriculture.

3.5 Data Analysis

Descriptive statistics such as percentages and frequencies were used to analyse the data. The Statistical Package for Social Sciences (SPSS®) version 20 and Microsoft Excel were used to analyse the data. Temperature and rainfall data that were solicited from the Swaziland Meteorology Department were used to establish temperature and rainfall trends at Mpolonjeni Area Development Programme. The primary data that were collected through the interview schedule were also used to establish whether there has been climate change in Mpolonjeni ADP. This was in terms of change in temperature, change in rainfall patterns and drought. The primary data that were collected from the sampled households was used to establish people's perceptions on the impacts of climate change on natural resources (pastures and water resources), biodiversity (genetics and breeding), and livestock health. To establish if livestock production is sensitive to climate change, the Ricardian regression Model was used. According to Mendelsohn, Nordhaus and Shaw (1994) the Ricardian model was developed to explain the variation in land value per hectare of cropland over climate zones. In several studies the land

value per hectare of cropland has been found to be sensitive to seasonal precipitation and temperature (Mendelsohn et al., 1994; 1999; 2001; Mendelsohn, 2001; Mendelsohn & Dinar, 2003). Seo and Mendelsohn (2008) reported that similar results had been found for livestock net revenue. In this study, the model was expressed as:

$$Y = \beta_0 + \sum[\beta_1 X_1 + \beta_2 X_1^2] + \sum[\beta_3 X_2 + \beta_4 X_2^2] + \mu$$

Where: Y = Livestock Net revenue for cattle or goats

X_1 = temperature variables

X_2 = Rainfall variables

β_0 = intercept

β_j= value of the j^{th} coefficient

μ = error term

The livestock data from 1983 to 2011 for the Lubombo region were converted into cattle net revenue and goat net revenue to come up with the dependent variable. Table 2 presents a summary of the explanatory variables and their expected signs.

Table 2. Explanatory variables used in the Ricardian Model and their expected signs

Variables	Measurement	Expected sign
Summer temperature	^oC	(-)
Winter temperature	^oC	(±)
Spring temperature	^oC	(-)
Autumn temperature	^oC	(±)
Summer temperature squared	squared ^oC	(±)
Winter temperature squared	squared ^oC	(±)
Spring temperature squared	squared ^oC	(±)
Autumn temperature squared	squared ^oC	(±)
Summer rainfall	mm/mo	(+)
Winter rainfall	mm/mo	(+)
Spring rainfall	mm/mo	(+)
Autumn rainfall	mm/mo	(+)
Summer rainfall squared	squared mm/mo	(+)
Winter rainfall squared	squared mm/mo	(+)
Spring rainfall squared	squared mm/mo	(+)
Autumn rainfall squared	squared mm/mo	(+)

4. Results and Discussion

4.1 Characteristics of the Households

Table 3 shows the number of households who own livestock. As shown by the results, 12.1% of the households own only cattle, 22.0% own goats only, and 32.2% own both cattle and goats. Thirty four percent (33.7%) of the households had no livestock.

Table 3. Number of Households that Own Livestock (n=323)

Livestock	F	%
Cattle	39	12.1
Goats	71	22.0
Both cattle and goats	104	32.2
No livestock	109	33.7
Total	323	100

Table 4 presents results of households that own either cattle or goats, or both in the five chiefdoms under the study area. From the sampled households, Ngcina had more households owning livestock (84.6%), followed by Ndzangu(84.4%), Kashoba (71.4%), then Mpolonjeni (62.3%) and lastly Kalanga (61.9%).

Table 4. Number of Households Owning Livestock (n=214)

Community	Studied households	Households owning livestock	%
Mpolonjeni	69	43	62.3
Kalanga	160	99	61.9
Ndzangu	32	27	84.4
Ngcina	13	11	84.6
Kashoba	49	35	71.4
Total	323	214	66.3

4.2 Climate Change Trends at Mpolonjeni ADP

Climate change effects include change in temperatures, erratic rainfall patterns, sea level rise and extreme events such as drought. To establish climate change trends in Mpolonjeni ADP, the respondents' perceptions were sought on change in temperatures, erratic rainfall patterns and drought. The results in Table 5 show that 94.7% of the respondents have experienced drought, and 99.4% said temperatures are increasing. The results also show that rainfall is not reliable in Mpolonjeni Area Development Programme with 98% of the respondents saying there are erratic rainfall patterns.

Figure 2 shows temperature trends at Mpolonjeni ADP. Since the year 2000 (28.4^{o}C) temperatures have been steadily increasing reaching temperatures as high as 30.1^{o}C around 2010. There has been a lot of variation in rainfall patterns. Figure 3 shows rainfall trends at Mpolonjeni Area Development Programme. From the figure, precipitation has varied from 200mm (recorded in 1990, 2003 and 2005) to a high of 1000 mm (recorded in 2000). Between 2011 and 2012 an average rainfall of 475mm of was recorded.

Table 5. Respondents' Perceptions on Climate Change

Climate change effect	F	%
Increasing temperatures	321	99.4
Erratic rainfall patterns	317	98.0
Drought	306	94.7

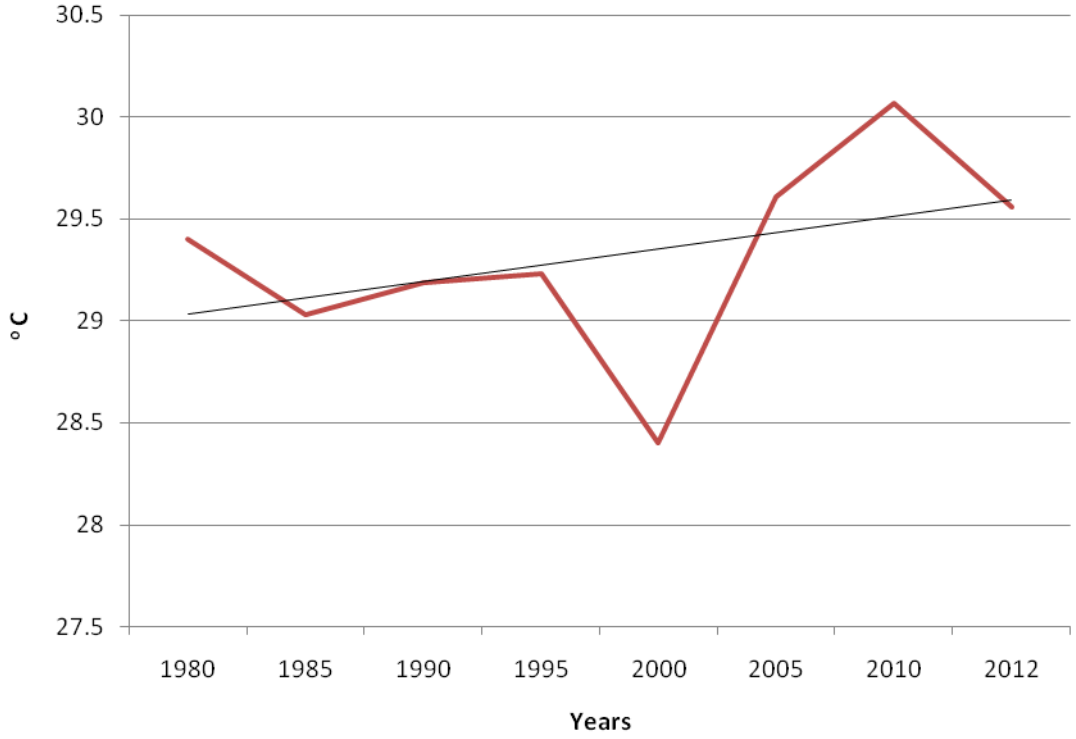

Figure 2. Temperature trend at Mpolonjeni ADP (1980 – 2012).

Source: Swaziland Meteorology Department

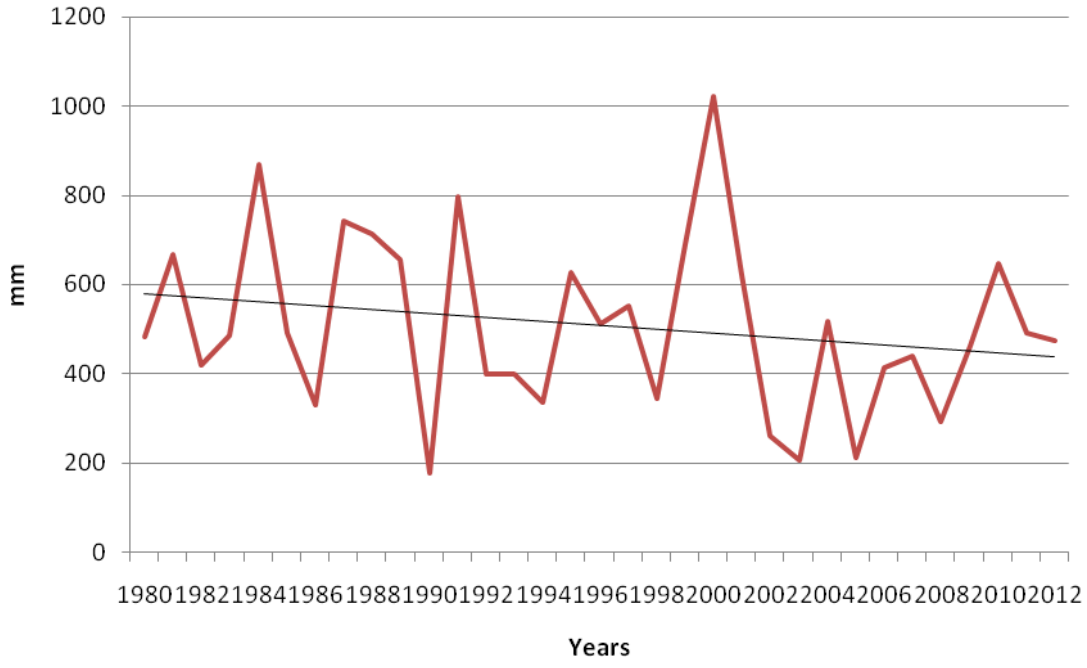

Figure 3. Rainfall trend at Mpolonjeni Area Development Programme (1980-2012).

Source: Swaziland Meteorology Department

4.3 Impact of Climate Change on Livestock Production at Mpolonjeni ADP

4.3.1 Respondents' Perceptions on the Impact of Climate Change at Mpolonjeni ADP

The impact of climate change on livestock production is measured through the effects of climate change on natural pastures (grazing grass and shrubs), water resources, livestock diseases and biodiversity (Thornton, 2010; Thornton & Herrero, 2008). Table 6 presents the summary of the respondents' perceptions on the impact of climate change on livestock production. The majority of livestock owners in Mpolonjeni ADP use natural pastures to feed their animals with only a few having other means such as buying hay for the animals. The observation of the respondents is that the quality of the pastures is deteriorating in the sense that the quantity of available grass and shrubs has gone down and that new, not very palatable grass and shrub species have invaded the pastures. This is because of rainfall shortage and variation. Available water sources include streams, earth dams and wetlands.

The only river in the area is at KaNdzangu (Umtindzekwa River). Thus the livestock owners rely on these water sources for their animals. Due to high temperatures and shortage of rainfall, the streams, wetlands and earth dams dry up sometimes. Most of the livestock farmers (76%) raise only the Nguni breed, since the conditions are suitable for this breed. Livestock owners have been troubled by outbreaks of diseases, with the most recent one being lump skin disease. Parasitic populations especially ticks, have increased. Livestock owners have experienced death of their animals due to a number of reasons: Around 40% of the livestock owners have seen animals dying due to unknown illnesses, 35% of the farmers suggested death due to shortage of drinking water, 35% of the farmers suggested death due to feed shortage and 12% of them suggested death due to excessive heat.

Table 6. Respondents' Perceptions on the Impact of Climate Change on Livestock Production

Climate Change Impact	Respondents	
	F	%
Less grass in pastures	159	49.2
Less shrubs in pastures	132	40.8
New grass species invasion of pastures	140	43.3
New shrub species invasion of pastures	145	45.0
Drying streams	201	62.2
Raising of exotic breeds	77	23.8
Outbreaks of livestock diseases	174	53.9
Increase in parasitic populations	200	61.9
Death of livestock due to excessive heat	39	12.1
Death of livestock due to shortage of feed	113	35.0
Death of livestock due to lack of drinking water	114	35.3
Death of livestock due to unknown diseases	140	43.3

4.3.2 Sensitivity of Livestock to Climate Change at Mpolonjeni ADP

The Recardian model was used in the study to establish if livestock is sensitive to climate change. Table 7 presents the results of the Recardian regression model. The results show that winter temperature was statistically significant ($p<0.05$). Winter temperature squared was also statistically significant ($p<0.05$). Winter rainfall and winter rainfall squared were also statistically significant ($p<0.05$), implying that goat net revenue is sensitive to winter temperature, winter temperature squared, winter rainfall and winter rainfall squared. The negative sign for winter temperature and winter rainfall imply an inverted U-shaped relationship between these variables and goat net revenue. On the other hand, the positive sign

for winter temperature squared and winter rainfall squared imply a U-shaped relationship between goat net revenue and these climate variables. The results indicate that none of the climate change variables affected cattle and this was not expected. The expectations were that some of these variables would also be significant for cattle net revenue. In general, summer, spring and autumn climate variables were not significant.

Table 7. Ricardian Regression Parameter Estimates

Variables	Goats		Cattle	
	Coefficient	p-value	Coefficient	p-value
Summer temperature	-118940442.5	0.155	821397572	0.476
Winter temperature	-406681733.1*	0.039	-1690200372	0.543
Spring temperature	-3961890.295	0.220	49476220.45	0.304
Autumn temperature	-10178433.52	0.321	70201416.44	0.638
Summer temperature squared	1762223.053	0.165	-12004708.53	0.494
Winter temperature squared	7686947.003*	0.038	32062245.49	0.453
Spring temperature squared	-14631	0.729	19.132	0.820
Autumn temperature squared	248768.686	0.235	-1803475.463	0.546
Summer rainfall	90995.412	0.107	-394761.305	0.590
Winter rainfall	-541377.101*	0.028	3221722.044	0.260
Spring rainfall	38899.598	0.609	168908.852	0.883
Autumn rainfall	-4714.952	0.979	-3879583.493	0.205
Summer rainfall squared	-76.229	0.193	658.173	0.429
Winter rainfall squared	2147.607*	0.036	-13156.669	0.285
Spring rainfall squared	-228.805	0.441	2621.101	0.559
Autumn rainfall squared	-172.084	0.643	8545.419	0.182

***** denotes significance at 0.05 level

5. Conclusions and Implications

5.1Conclusions

The conclusion that can be drawn from the findings of the study is that, firstly, temperatures are increasing at Mpolonjeni ADP, and there is variation in rainfall patterns. At some point the people have experienced drought, and all this points to a changing climate. Livestock production is under threat from the changing climate. This is because the natural pastures which a majority of the livestock owners rely on for feeding their animals are deteriorating in quality and the amount of fodder available. In addition to that, water sources available are not reliable as they sometimes dry up due to high temperatures and shortage of rainfall. Livestock has been lost due to among other factors excessive heat, shortage of water and feed and unknown diseases. Livestock production is sensitive to climate change in Mpolonjeni ADP, implying that there is an impact of climate change on livestock production.

5.2 Implications

Climate change has an impact on livestock production in the Mpolonjeni ADP. As a result government should come up with appropriate intervention programmes. Such programmes may include construction of larger earth dams and water canals to ensure that there is no shortage of drinking water for the animals. Livestock owners should organise themselves into schemes that would help construct water sources such as boreholes and provide water

harnessing tanks for the members.

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