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THE EFFECT OF CLIMATE CHANGE ON RURAL LIVESTOCK FARMING: CASE STUDY OF GIYANI POLICING AREA, REPUBLIC OF SOUTH AFRICA

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ABSTRACT

The key sectors of the Greater Giyani Municipality (GGM) economy are driven by manufacturing, trade, catering, government, finance, transport, communications and agriculture. The goal of this study is to analyse the effect of climate change on rural-livestock farming activities in the Giyani Policing Area (GPA). The effects are described in terms of agricultural yield, livelihood and production. Apart from other general factors that impact agriculture negatively, the success of rural livestock farmers in the GPA is greatly influenced by turbulent climate change aspects. The current paper further identifies the effect of climate change (e.g. drought, temperature and rainfall) on farmers and key stakeholders while establishing how they handle challenges associated with climate change in the study district. Data were collected from 22 participants, including officials associated with Veterinary Services and Land and Infrastructure of the Department of Agriculture, Forestry and Fisheries (DAFF) in the GGM. Taking part in the Key Informant Interviews (KIIs) were officials from the DAFF-2:1, and 20:10 rural livestock farmers from Makosha and Xikukwana villages, respectively, were used for the Focus Group Discussions (FGD's). The main findings show that the rural livestock farmers in the GGM are highly vulnerable to the consequences of climate change, shown by the overall decline in livestock farming practices in the area caused by associated health and nourishment problems brought forward by climate change. The links between climate change and rural livestock farming were examined in the process of describing that droughts, excessive temperatures and heavy rainfall has a detrimental effect on rural livestock farmers in the selected areas. This paper further investigates the strategies that rural producers utilise to maintain sustainable economic viability concerning animal health, safety and nutritional requirements while preparing for unforeseen risks. In conclusion, this paper enforces the statement that the identified climate change factors do have a significant effect on rural livestock farming, despite the infrequent and varied occurrence between regions. This paper recommends that the relevant stakeholders should be encouraged to be involved in proactive and reactive activities concerning the climate change, to avoid unnecessary negative effects implicating national food security.

Keywords: Agriculture, drought, rural livestock farmers, rainfall, temperature

1. INTRODUCTION

Different regions of the world are currently experiencing vast effects of climate change, and this trend is predicted to continue into the future. Some parts of southern Africa are predicted to have less rainfall and more wind, other parts can contrastingly have more rainfall, hotter

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and more humid conditions. It is foreseen that even the length of seasonal plant growth can vary in the future, which in turn affects the agro-ecosystem's production potential (Climate System Analysis Group, 2015:np).

Previously, rural livestock producers dealt with small incidences of livestock (sheep) theft, however producers are currently (2016) faced with large scale livestock theft in the form of organised syndicates (87%), with the remainder attributed to subsistence theft (13%), largely attributable to poverty. The stock thieves are able to steal truckloads of livestock at a time and these operations are organised and supported by individuals from different socio-economic standings as described by the South African Police Service (SAPS) Research Unit (2010:np). Apart from the difficulties caused by stock theft, rural livestock farmers are additionally faced with problems due to climate change. Patterns of climate change across South African rural areas and GGM has been identified over a long period of time.

The earth's atmosphere is a mixture of gases, including 78,08% Nitrogen and 20,95% Oxygen. The rest (less than 1%) is made up of water vapour, Argon, Carbon Dioxide, Neon, Helium, Methane, Hydrogen, Nitrous Oxide and Ozone (Chetty, Isaac, Manganye, Mpondwana & White, 2012:324). Some traces of Krypton, Xenon and Radone can also be found in the atmosphere. Of all the recognised gases, that contribute significantly to the 'greenhouse effect' influencing global warming and climate change are; water vapour, carbon dioxide, methane, nitrous oxide and ozone. The increases in concentration of these greenhouse gases (GHG) has led to a rise in the average temperature on Earth defined as global warming. The global warming process contributes to an ongoing change in the earth's weather pattern referred to as climate change (Chetty, *et al.* 2012:324).

The main objective of this paper was to identify the actual perceptions of both prominent rural livestock farmers and DAFF officials from the GPA in the Limpopo Province regarding the effects of climate change, and its implications concerning rural livestock farming. Furthermore, the researcher aims to introduce a baseline in understanding the implications of climate change, and bring about reactive and proactive responses provided by rural livestock farmers and relevant stakeholders to develop a holistical approach to address this phenomenon.

2. THE PROBLEM FRAMEWORK

Estimating the implications of climate change on rural livestock farming, has received little attention in academic research up until now. The current study attempts to fill in the recognised research gap. In an effort to do so, the focus of this paper was based on GPA, concentrating on two villages (Makosha and Xikukwana) classified under ward 14 of GGM in the Limpopo Province. The majority of literature researched for this study predicts that the African continent will be influenced the most by climate change. Larger areas of agricultural production yields can decrease over 50% by 2020, as a result of an increasingly hotter and drier climate that threatens food security and livelihoods in most parts of Africa [UNFCCC (2008); Maponya & Mpandeli (2012:5276-5277)].

As specified, the Limpopo Province has already experienced some of these weather events, including floods and droughts. One notable example is the floods which destroyed crops, infrastructure, and effected the harvesting period during 2000 and 2012. Due to the economic impact of these events, it is important to recognise changing rainfall distribution patterns, as

well as extreme temperature trends that are likely to increase the frequency and magnitude of extreme weather events such as drought (Climate System Analysis Group, 2015:np).

From October 2012 to February 2013, maximum rainfall across the Limpopo province was recorded to be below normal. Maximum mean temperatures remained cooler than the average annual previously recorded temperatures in the entire province. The El Niño-Southern Oscillation (ENSO) was in a strong El Niño phase for the forecast period, resulting in drought circumstances in some parts of the province negatively affecting GPA livestock farmers in the Makosha and Xilukwana villiges. Consequently, between 171 and 134 livestock were reported to have died in the Makosha and Xikukwana villages respectively, surpassing the number of reported stock theft cases for the period of 2012 (e.g. 71), 2013 (e.g. 36) and 2014 (e.g. 43). By the time this paper was drafted, the livestock farming sector was already undergoing a serious decline in production as the area was negatively influenced by drought and the shortage of available drinking water for various livestock.

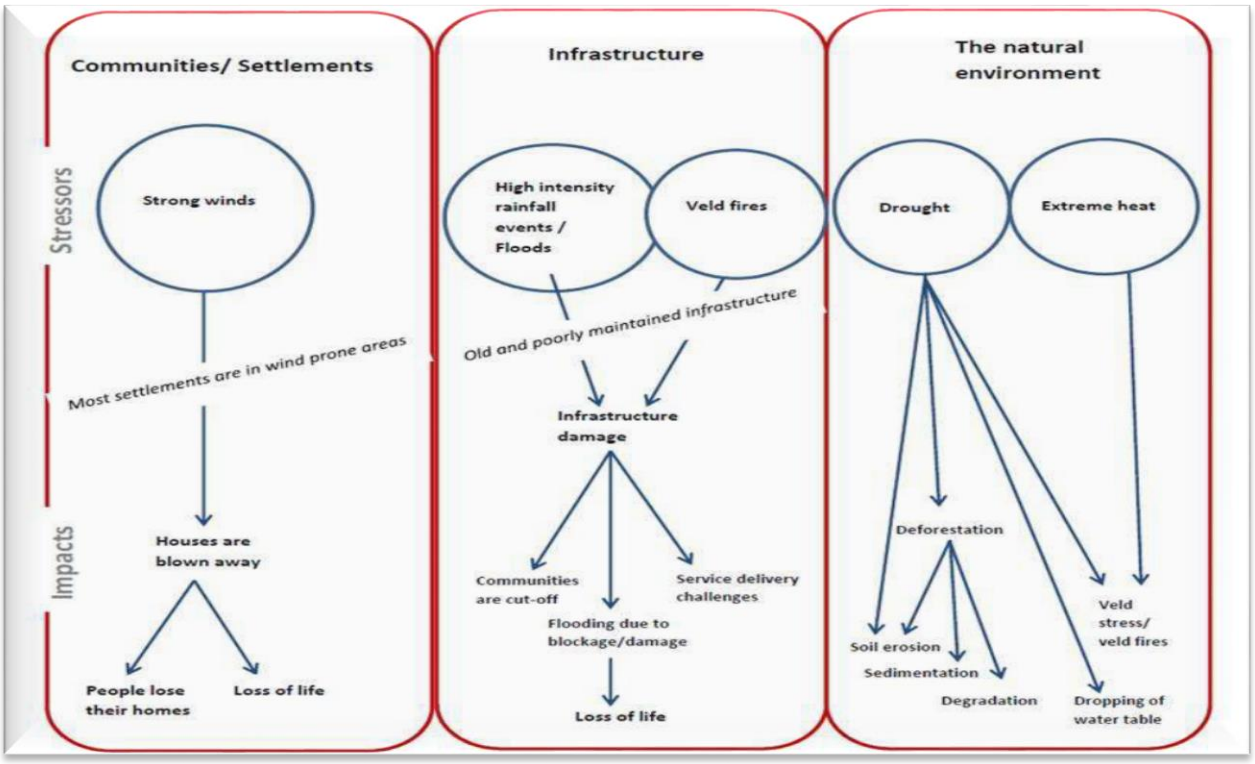

Figure 1: Stressors currently influencing the Disaster Management Sector (Brodrick, Rahiz & New, 2014:110).

The red boxes in Figure 1 outlines the systems that focus on *Communities/Settlements, Infrastructure* and the *Natural environment*, with the stressors affecting those systems outlined in blue circles. The arrows point to the specific impacts identified for the different stressors, within the different systems. Figure 1 also identifies the relation of climate related stressors and disaster management, to confirm the central role of climate change in disaster management. The identification of these climate related stressors and their impacts were correlated with the findings of the Disaster Risk Assessment and Disaster Risk Reduction Report for Mopani District, 2012 as cited in Brodrick, *et al*. (2014:110). The report highlights that Letaba and GGM experienced fires, drought, dam failure, floods, deforestation, erosion,

hazardous material, epidemics, water pollution, water management, crime and extreme weather cited as priority threats.

Communities and settlements in Letaba and GGM were identified to be prone to stress caused by change in wind patterns that results in damage to homes, loss of human life and the death of livestock. It was also noticed that many rural settlements in the area are sensitive to such damage, as they are located in wind prone areas. Moreover, infrastructure damage, due to veld fires, heavy rainfall or flooding, can disrupt service delivery, lead to the loss of livestock and can result in communities being cut-off from basic facilities such as hospitals. Some infrastructure elements are particularly sensitive to damage due to their old age and poor maintenance.

The natural environment, the resource base on which people live and from which they depend, is prone to stress from climate related factors like drought and extreme heat. Resulting impacts, such as soil erosion, a dropping water table and veld degradation and fires, depletes this resource base and requires disaster management responses. The resource depletion further requires responses that aim to restore the resource base, and that promote sustainable resource use. These findings give an indication of how people in Letaba and GGM handle disaster management while being vulnerable to a number of climate related stressors, with the disaster management sector having to develop approaches to respond.

Table 1: Summary of sectoral analysis (Brodrick, *et al*. 2014:110)

Summarised key stressors currently facing the agricultural, water, health and disaster management sectors				
High temperatures	Below normal rainfall	Drought	Heavy rainfall events/ floods	Low temperatures/ frost
Strong winds	Veld fires	Zoonotic disease - Foot and Mouth	Disease	Vandalism & illegal connections
Aging infrastructure	Overloaded water supply and waste and water treatment systems	Waste management inadequacy	Shortage of potable water/ lack of laboratories and related services	Sale of unsafe foods

Table 1 indicates that climate change is real, despite the fact that many individuals are still sceptical. More severe weather events, drought temperatures are rising, heavy rainfall, floods, strong winds, veld fires are experienced creating major challenges to the rural livestock farming sector.

Table 2: Linking of livelihood activities with the livelihood assets that are currently limited or lacking (Brodrick, *et al*. 2014:104)

	Human assets: Skills, knowledge and info, ability to work, health	Natural assets: Land, water, wildlife, biodiversity, environment	Financial assets: Savings, credit, remittances, pensions	Physical assets: Transport, shelter, water, energy	Social assets: Networks, groups, trust, access to institutions
Small-scale crop and livestock farming	X	X	X		X

Table 2 illustrates the analysis of income generating activities and some of the stressors faced in making a living from these activities. Livelihoods in Letaba and GGM can be considered vulnerable in that they have limited financial, physical, human, natural and social assets to deal with the stressors. Apart from the agricultural activities, for which climatic stress plays a crucial role, all of the stressors facing income-generating activities are non-climatic.

3. PROVINCIAL BACKGROUND: CLIMATE CHANGE EFFECTS AND RESPONSIVE STRATEGIES WITHIN LIMPOPO PROVINCE

Flora and fauna in the form of crops and livestock are affected by their direct environment. An organism's surroundings are identified as its environment, and can include varying conditions such as sunlight, rainfall and temperature, as well as the influence from other living organisms. The different parts of the organism's environment interact and affect the plants and animals within it negatively or positively.

In this paper, the researchers argues that drought is a recurring problem in Limpopo Province characterised by harmful vast effects, further branding this province as an unofficial drought capital of South Africa, if not the world (selected villages under GGM included). In response to this epidemic, Mpandeli (2005) as cited in Maponya and Mpandeli, (2012:5276), mentions that in times of drought, excessive temperatures and heavy rainfall, different coping strategies should be identified, examined and shared amongst a range of role-players, including the National Agro-meteorological Committee, research institutions such as the Agricultural Research Council (ARC) and the South African Weather Service (SAWS). Limpopo's rural livestock farmers should also be encouraged to use drought-resistant cultivars during drought periods to prevent food shortages.

3.1 Monthly climate outlook

Table 3 indicates the monthly climate outlook relating to rainfall and temperature, seasonal rainfall (October 2012 to February 2013), and seasonal temperature forecast (October 2012 to February 2013) in the GPA.

Table 3: Monthly climate change of GPA: The probability of receiving both above and below normal total rainfall for the period (DAFF, Limpopo Provincial Government, Republic of South Africa, 2012:3).

The probability of receiving both above and below normal total rainfall for the period:		
October 2012-December 2012	November 2012-January 2013	December 2012-February 2013
Enhanced probabilities for below normal rainfall totals are expected in the entire province.	No enhanced probabilities for below normal or above rainfall totals are expected over the entire province.	Enhanced probabilities for below normal rainfall totals are expected for the entire province.

Table 4: Monthly climate change of GPA: The probability of receiving both above and below maximum temperatures for the period (DAFF, Limpopo Provincial Government, Republic of South Africa, 2012:4).

The probability of receiving both above and below maximum temperatures for the period:		
October 2012-December 2012	November 2012-January 2013	December 2012-February 2013
Enhanced probabilities for below-normal maximum mean temperatures are expected for parts of Limpopo.	No enhance probabilities for below or above mean-maximum temperatures are expected over the entire province.	Enhanced probabilities for below mean-maximum temperatures are expected for the entire Limpopo province.

The following can be deduced from Table 3 and Table 4:

- Rainfall was anticipated to be below normal from October of 2012 and this trend was also expected to extend into the New Year (2013) over Limpopo province.
- Maximum mean temperatures were expected to remain cooler than normal in the entire province.
- ENSO was currently in an El Niño phase and was predicted to persist in ENSO phase for the forecast period.
- Farmers were advised to prioritise drought tolerant cultivars. In addition, farmers were encouraged to utilise seven-day weather forecasts for short-term planning (DAFF, Limpopo Provincial Government, Republic of South Africa, 2012:2-7).

4. RESEARCH DESIGN AND METHODOLOGY

According to Bezuidenhout (2011:48), a research design is the blueprint, procedure or plan of action used to analyse a chosen topic. Mouton (2001:55) also promotes that a research design is "a plan of how one intends conducting the research, by focusing on the end product". This framework correlates with the guideline used for writing this paper. A qualitative research approach was used in the current study. The validation of this approach is reinforced by White (2002:81), who states that qualitative research is more concerned with understanding social phenomena from the perspective of the participants. This takes place through the researchers' participation in the daily life activities of those involved in the research and thus corresponds with the main objective of this paper.

Purposive sampling was adopted in this paper to ensure that participants were composed out of the most characteristic and representative attributes of the population while making judgements about the prior selection criteria. This type of sampling is regarded as the most important type of non-probability sampling. While utilising this method, researchers rely on their experience, ingenuity and/or previous research findings to deliberately obtain units of analysis in such a manner that the sample they obtain may be regarded as being representative of the relevant population (Welman, Kruger & Mitchell, 2005:69). In selecting settings and behaviour, the researcher used his own discretion to select both public and private methods. Public methods are non-secretive, and this was directed towards the FGDs.

GGM has a population size of 244217 (by the time of writing this paper), which makes it the second largest municipality in terms of population contribution (22%) in the Mopani District. According to the 2011 Census, 99,5% of the population are black Africans, with the other population groups making up the remaining 0,5% with a 0,14% growth rate. The estimated population for Makosha village was 4 818 with 1 218 livestock farmers, while the Xikukwana village comprised of 2 618 people with a total of 658 livestock farmers. When this paper was finalised, an overall 35.9% of the GPA population owned various livestock and 60.7% of households practiced livestock farming. Livestock farming is regarded as income generating activities in the GGM, comprising of small-scale crop and livestock farming (e.g. beans, potatoes, green pepper, tomatoes, banana, apples, cattle, pigs, chickens, goats, commercial farming-crop farming, and livestock farming of poultry) (Statistics South Africa, 2014 & 2015:np).

Livestock farming contributes significantly to the livelihoods of people living in the rural areas of developing countries (De Haan, Van Veen, Brandenburg, Gauthier, Le Gal, Mearns

& Simeon, 2001:np). South Africa is no different, especially the GPA. Amongst various challenges that are faced by South African livestock farmers, adaptation to climate change remains particularly problematic. In addition, rural livestock farmers are commonly affected by their surrounding environment.

The population used for the paper in question consisted of prominent livestock farmers and DAFF officials in the GGM. In connection with this statement, the sample was purposively selected from the inner city of GGM and in particular two villages outside the city centre. The sample included 22 participants-2:1. Veterinary Services and Land and Infrastructure officials from DAFF and 20:10 participants in the group consisted of 20:10 prominent rural livestock farmers from the respective villages (Makosha and Xikukwana). The selected sample were viewed by the researcher as the most accurate representative for the GPA communities while relying on the participants' experiences of climate change.

Table 5: Communal climate change and rural livestock farming experiences (Researchers illustrations)

No.	(10) Sections under Xikukwana Village and other (3) Sections under Makosha village	Estimated population per section	Approximate livestock farmers
	Sections under Xikukwana Village:		
1.	Boyi	300	52
	Chavani	100	35
3.	Gijima	60	30
4.	Eco park	700	115
5.	Hatlani	110	20
6.	Masiya	170	33
7.	Mbyindlani	700	78
8.	Milunghisi	70	17
9.	Pfalanomo	206	141
10.	Zambiya	202	137
Sections under Makosha village:			
(11). Migoni		700	179
(12). Makosha / Hatshama		1000	242
(13). Risinga		500	139
OVERALL SECTIONS: 13		TOTAL ESTIMATED POPULATION PER SECTON: 2618 (Xikukwana) and 2500 (Makosha) = 5118	TOTAL APPROXIMATE NUMBER OF LIVESTOCK FARMERS PER VILLAGE: 658 (Xikukwana) and 560 (Makosha) = 1218
Note: Villages population statistics were provided by the responsible traditional leaders (e.g. estimated population per section and approximate livestock farmers).			

Paterniti (2012:np) views FGDs as a small group discussion guided by a set of research questions that explore attitudes, values, and behaviours, emphasising a particular topic or event and a homogenous yet diverse group led by a trained discussion leader and KII's. The

purpose of a KII is to collect information from a wide range of people, including community leaders, professionals, or residents who have first-hand knowledge about the community.

These community experts, with their particular knowledge and understanding, can provide insight into the nature of problems and give recommendations for solutions, University of California, Los Angeles [UCLA] Centre for Health Policy Research (2015:np). The fieldwork was conducted from 5 October 2012 to 5 February 2013 in the GPA with the adoption of FGDs and KII's interviewing methods. This was coupled with unstructured questions asked to the participants as a mode of data collection for this paper. The researcher launched explorative investigation to conduct pre-testing of the interview schedule, in support of the research problem and objectives of this paper. Welman, *et al*. (2005:201) explain that this type of interviewing helps to clarify concepts and problems and allows the establishment of a list of possible answers and solutions which, in turn, facilitates the construction of further questions, the elimination of superfluous questions, and the reformulation of ambiguous ones. However, it is evident that climate outlook may be interpreted in different ways, therefore, participants were given the opportunity to express themselves freely about their knowledge and beliefs about the concept under discussion.

Two FGD's (20:10) were conducted with prominent rural livestock farmers from selected villages (Makosha and Xikukwana). The interview guide to the participants examined the trends of climate change, including factors such as temperature, rainfall and drought over time, which may result in livestock fatalities basing more conclusion on the condition of drinking troughs, earth dams, reservoirs, grazing camps and livestock, and the number of livestock that died as a result of extreme temperatures, excessive seasonal rainfall and drought in the GPA.

Two KII's and two FGD's were conducted in GPA, with the participants drawn from rural areas and the inner city:

- An inner-city area (DAFF officials KIIs), and
- Rural areas outside the inner city (FGDs).

The participants were made available and requested to participate in the research. Gender, age, educational background and economic differentiation did not play a role in this regard. All 22 participants were Tsonga speaking. Furthermore, population validity was used in this research since it was very difficult and practically impossible to obtain the relevant information from the entire population within the targeted locations of the current study. Therefore, the targeted individuals were native residents of GGM and DAFF officials, and were mainly rural livestock farmers with different socio-economic status.

For this paper, the collected data was analysed through the use of a voice recorder and note taking while conducting the said FGD and KII's. The KII's and FGD's were conducted with the identified target population of this study in the GPA. By analysing the data derived from these interviews, the researcher obtained an overall picture of the perceptions of the participants on the subject matter. Qualitative findings gained from the KII's and FGD's enabled the researcher to present findings of this paper in a meaningful context. The solicited data was analysed according to the thematic method. In connection to this statement; the researcher further strived to link concepts to each other in terms of a sequence, as oppositional sets or as sets of similar categories that will eventually be interweaved into theoretical statements, as expressed by Neuman (1997:421).

De Vos, Strydom, Fouche and Delport (2005:339) further elaborate that the salient grounded categories of meaning held by participants in the settings. This method assisted in compiling data into themes, sub-themes and categories. The participants of this paper were given details of the intended paper and offered an opportunity to contribute their views in person. Moreover, it was explained to the participants that this paper was exploratory in nature. The same sets of questions were asked to all the selected participants. The results obtained were generalised to the entire population. The participants were further asked for their views on the effects of climate on rural livestock farmers, and to indicate what kind of modifications might be introduced to overcome the challenges in responding to predicted change in climate. They were reassured that no individual sources would be revealed, and that a summary of the report would be made available to them on conclusion of the study.

5. FINDINGS AND DISCUSSIONS

5.1 Paper finding 1: Turbulent climate change

Variable temperatures and excessive seasonal rainfall are not unique to the Limpopo province, which is also branded as a drought prone province. As a result, the province has experienced reduced available grazing and water availability for livestock and irrigation, which has negatively impacted the agricultural sector. Of all South African provinces, Limpopo was the worst affected by drought in the past eight years (2004-2012), where dams were only 50% full, compared with 84% in the late nineties. The agricultural sector is seen as an important source of livelihood for Limpopo, especially in rural areas. Extreme climate changes make it difficult for livestock farmers to cope with all the various financial implications/ challenges? It is quite disturbing that in the Makosha and Xikukwana villages, livestock farmers were forced to sell their livestock in the year 2012 and 2013 respectively due to the identified climate change conditions. This presents a serious challenge for agriculture activities resulting in food scarcity, not only in the province, but also in all rural communities across South Africa.

An interview was held with an affected livestock farmer residing at Makuleke Village in Malamulele, under Vhembe district on the 6H30-7H00 current affairs (Munghana Lonene FM, Friday, 12/10/2012). At the time of the interview, 30 cows of his stock were dead. He further mentioned that there was no grazing pasture, water or water tank. When the call was made he had been in the veld looking for food and water for the remaining cattle. Regarding available water sources, he said that the wells and dams were also dry. In response, the Provincial Head of DAFF for Limpopo province, Mr. Mortimer Mannya, was asked the following question by the current affairs presenter during the same interview: *"Many areas in Limpopo province are hard hit by drought leading to the death of livestock, thus, what are the hints in place to combat further mortalities?"* In responding to the posed question, Mr Mannya mentioned that areas in Limpopo Province are exposed to very harsh weather and, in essence, there are many high-risk areas. He went on to say that the livestock farmers should be given early warnings of exposure that they can expect over a particular period of time.

The second question was: *"Is there any advice you can give to livestock farmers in order for them to limit their losses?"* This is what he said:

- They must sell their livestock early when approaching drought seasons;
- They should register as livestock farmers with the veterinary service official in order to be given fodder in desperate times like these; and

- They should note that the supply of fodder is not adequate, however, the Provincial Disaster Management say they are doing the best they can to meet the demand.

Within five days after the initial interview, another interview was conducted with Mr. Chauke, residing at Makuleke village in Malamulele, under Vhembe district by the radio station Munghana Lonene FM, 2012, on the 9H00 evening news. This producer mentioned that he lost 134 cows due to the drought, and went on to state that his farming business is suffering due to the livestock losses. He also mentioned that at Makuleke Block H, a further 171 cows were dead. He then blamed the DAFF for not helping them with anything and said that they do not know who to turn to. He concluded by saying that "even where I am standing right now, some of my livestock has collapsed."
Based on the responses from the participants, it is clear that beyond the initiatives that revolve around educating, empowering and involving the livestock community as well as the general public to prevent and protect their livestock against any challenges, drought remains problematic in the area.

5.2 Paper finding 2: Severe livestock mortalities

During the FGD's, one of the participants mentioned that 30 cows of his stock died due to the drought. Overall, 305 livestock died in Makosha and Xikukwana villages collectively for the period of October 2012-February 2013. The Provincial Disaster Management does not seem to meet the demands in terms of fodder supply in the area.

The DAFF officials indicated that the number of livestock had died because of drought. They mentioned that the GGM is already becoming increasingly prone to periodic water and grass shortages in the grazing camps and irrigation scheme, which threaten necessary developments and even the sustainability of existing industry and agriculture. This phenomenon affects the farmers drastically in the following ways:

- **Financial implications:** Drought condition was still persisting, in August 2012, a delivery schedule for dry fodder for 2012-2013 financial years was received for Mopani District distributions, while the DAFF was still waiting for the service provider on the other hand. In addition, drought, excessive temperatures and rainfall in the GPA (Table 6) affected the following numbers of livestock.

Table 6: Livestock mortalities caused by drought in the GPA of GGM (Researchers illustrations)

Villages and number of cattle died as a result of drought				
1. Makosha (171)	2. Dumazi (14)	3. Basani (12)	4. Xitlakati (11)	5. Zava (4)
6. Mphagani (20)	7. Ndhambi (6)	8. Loloka (11)	9. Guwela (6)	10. Kheyi (5)
11. Xikhumba (5)	12. Shawela (3)	13. Nkomo B (11)	14. Nkomo A (4)	15. Vuhehli (3)
16. Phalaubeni (2)	17. Sabulani (10)	18. Mushiyani (16)	19. Mbaula (22)	20. Makhuva (13)
21. Maphata (3)	22. Botshabelo (2)	23. Ximausa (60)	24. Blinkwater (13)	25. Rivala (6)
26. Maswanganyi (5)	27. Nkuri A (18)	28. Sefasonke (8)	29. Mapuve (10)	30. Tomu (16)
31. Gawula (22)	32. Mavalani (23)	33. Nwadzekudzeku (4)	34. Khakhala B (15)	35. Khakhala A (8)
36. Block 3 (4)	37. Thomo (6)	38. Homu 14B (13)	39. Xikukwani (134)	

In summation, by the time of conducting the fieldwork, approximately 719 livestock were reported dead resulting from drought conditions from different villages around GGM. The researcher personally visited the traditional leader of each village to compile the statistics above. It was clearly indicated by the participants and the traditional leaders, in isolation from the participants, of this paper that the experienced climate change period was not associated with witchcraft connotations at all costs. The DAFF participants concluded by stating that no marketing information was available, but sales were done through *Makhoma* meat butchery in the GGM, and fodder is urgently needed, the participant concluded.

5.3 Paper findings 3: Unfavourable climate change conditions

The veld condition was deteriorated and disease outbreak on livestock resulting in mortalities was witnessed. Dam water was used for both livestock and human consumption, and some of the earth dams were silted, damaged or empty. A large number of livestock died due to the effect of the drought. It was also mentioned by the participant that the GGM is already becoming increasingly prone to periodic water and grass shortages in the grazing camps and irrigation schemes. These shortcomings threaten necessary developments and even the sustainability of existing industry and agriculture.

During the KII with DAFF officials, it was revealed that the climate conditions around GGM received 15-millimetre rainfall in September 2012 and the daily temperature ranged between a minimum of 15ºC and a maximum of 36ºC. The participant went on to mention that in line with veld and livestock conditions, the following was indicated as the most problematic areas for livestock farming in the area (e.g. not in order of importance):

- The veld condition has deteriorated, and
- Livestock disease outbreak and livestock mortalities reported.

In general, grazing conditions were very bad and fodder supplements were urgently needed. The participant further cited the following examples below:

- 680 livestock farmers applied for fodder at Muyexe depot, and
- 833 livestock farmers applied for fodder at GGM depot.

The aforementioned clearly indicates that the demand for the dry fodder was of high demand during this time (e.g. 15 13 total application received). The FGD's revealed that the demand and supply was not meeting the producer's needs. However, the acknowledgement of good work by the DAFF officials was highly cited. They indicated that there are many livestock farmers in the area in anticipation of feed supply. Thus, the DAFF faced the shortfall in supplying them with additional feed. It is about time for the participants to come up with alternative ways of responding to climate change. With not much reliance placed on the local DAFF for the preservation of their livestock, the local DAFF on the other hand should educate the livestock farmers about the responsive ways to climate change to enhance their relations with the livestock farmers across GPA communities for future purposes. The DAFF participants further mentioned that dams are used for both livestock and human consumption and some of the earth dams are silted, damaged and empty. They were in need of repair, cleaning and dredging. Table 7 indicates the condition of dams in the GGM.

Table 7: Conditions of dams in the GGM (DAFF, Limpopo Provincial Government, Republic of South Africa, 2012:2-7)

Dams	Earth Dams	Boreholes for livestock watering	Rivers for livestock watering
Middle Letaba Dam was at 1.%	Block 3 was at 0%, Blinkwater was at 1%	All boreholes experience shortage of water due to lack of rainfall	Klein Letaba and Middle Letaba still flowing, but at a lower level
Nsami Dam was at 19,4%	Vuhehli was at 0%, Ndhambi was at 0%		
	Tomu was at 0%, Skhunyani was at 1,5%		
	Nwamankena was at 0%, Shimange was at 0%		
	Dingamazi was at 1%, Mahlathi was at 0%		
	Phalaubeni was at 1%, Shawela was at 0%		
	Vuhehli was at 0%, Xivulani was at 0%		
	Gawula was at 0%		

In summation, the DAFF participants recommended that due to the shortage of stock watering, additional bore holes and earth dams are needed to avoid the current situation and future livestock mortalities owing to drought.

6. CONCLUSION AND RECOMMENDATIONS

In order to prevent further global warming and its effects, we need to reduce the amount of greenhouse gases in the atmosphere. We can do this by reducing greenhouse gas emissions (e.g. change to renewable forms of energy, save energy, recycle waste, use public transport and use clean technologies), increasing carbon sinks (e.g. protecting existing trees and forestry and plant new trees), working with other countries of the world (e.g. all the countries needs to work together to bring greenhouse gas emissions under control and prevent further climate change as a global problem such as climate change needs a global solution) and reducing our own carbon footprint (e.g. a measure of the total greenhouse gas emissions through the activities of a country, an organisation or a person in one year -electricity usage-activities such as heating, lighting and electrical appliances, transport for travelling purposes, waste production–waste produced, recycling and compost waste and fires-wood and fossil fuels such as coal burned for cooking or heating) as described by De Fontaine, Freedman, Marchant, Mckay, Simenson, Van der Merwe and Webb (2012:334-336).

Climate change predictions of constant change in temperatures, excessive seasonal rainfalls and drought conditions in the GPA of GGM are beyond control of rural livestock farmers. With acknowledging that weather and climate patterns play a significant role in livestock farming, climate change is identified as the affect varying weather conditions have on rural livestock farmers. Therefore, the impact of climate change on rural livestock farming depends on many associated factors that can be detrimental to the economic viability and sustainability of livestock production. It suggests that agriculture can be a major contributor to the local economy, if the climatic conditions are favourable. Agriculture has been the backbone of the Giyani local economy; therefore, the local municipality should fast track arable land and irrigation schemes.

It is suggested that the strategies and guidelines outlined are employed by rural livestock farmers to respond to the effects and implications caused by unfavourable climate conditions in the GPA of G MM, and should include the following:

- Close collaboration, interaction and information exchange between relevant role-players within GPA (e.g. more especially the DAFF) to respond to turbulent climate change. Rural livestock farmers should learn more about how they can adapt to climate change impacts. Working in line with Animal Identification Act 6 of 2002, regulation 11 to receive the necessary aid in dry fodder supply.
- Promoting greater awareness within GPA in understanding the risks and actions that can instigate the behaviours of relevant stakeholders and enable livestock protection and preservation against climate change. Furthermore, they should be encouraged to sell mature, marketable animals to help prevent overstocking and minimise livestock mortalities during excessive climate change periods.
- To respond to climate change conditions. Enhanced nutritional value of dry grazing should be exercised. This is done by following correct farming practices to keep stocking rates in balance through carrying capacity, to ensure livestock good conditions and provide lots of drinking points to anticipate drought and change in temperatures.
- Enhanced nutritional value of dry grazing feed fields with links should be improved. Links should (in most cases) provide phosphorous, urea (to help the breakdown of dry vegetation and grazing fields for livestock), salt and molasses (e.g. deficiencies differ according to vegetation composition climate and analysis of vegetation samples can benefit the decision for supplement composition).
- Ensuring that Kyoto Protocol based on agreement made by 170 countries reduce greenhouse gases that cause climate change and Conference of the Parties [COP](e.g. COP17) resolutions (e.g. details of the Bali Action Plan, goals for reducing GHGs emissions by 2050, time frames for the peaking of GHG's, a second commitment term for the Kyoto Protocol and development of a Green Climate Fund) as suggested in 2011, at COP 17, Durban, South Africa are adhered to by the parties involved during yearly meetings to assess progress in dealing with climate change.
- More empirical research needed for climate change on livestock farming. Despite the importance of livestock to poor people and the magnitude of the changes that are likely to befall livestock systems, the inter-section of climate change and livestock in developing countries (e.g. South Africa included) is a relatively neglected research area (Thornton, Van de Steeg, Notenbaert & Herrero, 2009:113).
- The need for a mix of technological, policy and institutional innovations is required. It is emphasised that on the technology side, improvements should be linked to a combination of feed and nutrition, genetics and breeding, health and environmental management options, with different combinations appropriate to different systems (Thornton, *et al*. 2009:113).
- With climate change, significant changes in improving physical and biological systems have already occurred on all continents and in most oceans (e.g. South Africa should follow the lead) and most of these changes are in the direction expected with warming temperature (e.g. this can further help the livestock farmers going forward) (Rosenzweig, *et al*. 2008 as cited in Thornton, *et al*. 2009:113).

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