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Determination of the Status and Factors Influencing Occurrence and Adequacy of Panicum maximum (Guinea grass) in Tana Delta, Kenya

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Abstract
Panicum maximum is becoming extinct in Tana Delta, Kenya. The grass is declining at an increased rate due to poor management of this open to all natural pasture. The purpose of this study was to establish an alternative effective management practices for *Panicum maximum* as a source of pasture for pastoralist communities in Tana Delta. The findings of the study show that *Panicum maximum* has become inadequate (97%) for livestock in Tana Delta. Additionally, the satellite images correlates the above outcome that grass quantity has reduced over the years - when the satellite image of 1992 compared to that of 2015. The results further showed that inadequate rainfall (78%), lack of flooding (50%) and overstocking of herds in the grazing land (45%) as the main reason for *Panicum maximum* reduction. From the study, this reduction in quantity is therefore attributable to two main factors, namely; reduction in amount of rainfall and overstocking of cattle in the communal grazing areas. The study further concludes that hay production among the community formed a potent mitigation strategy against feed scarcity during dry seasons.
Keywords: *Panicum maximum,* Satellite images, adequacy

1. INTRODUCTION

Guinea grass (*Panicum maximum*) is native to 13 tropical and Sub tropical Africa including Angola, Benin, Botswana, Cameroon, Cote D'Ivoire, Democratic Republic of Congo, Eritrea, Ethiopia, Ghana, Kenya, Lesotho, Liberia and Malawi originally. Further, this grass has been introduced to almost all tropical countries as a source of animal forage (Aganga and Tshwenyane, 2004). Its occurrence ranges from sea level to approximately 2000m. It is found mostly in scattered tree grasslands, open tall tree glades, coastal regions and bush vegetation (McCosker and Teitzel, 1975).

The grass has played different roles in different countries, namely, in Northern Queensland *Panicum maximum* improves grasslands and livestock production (Grof and Harding, 1970). It is used as cultivated grass for both pasture and hay. *Panicum maximum* has been successfully ensiled in Hawaii and silage production can be effectively integrated with pasture management in the dairy industry (Aganga and Tshwenyane, 2004). On other hand the grass plays an important role in the habitat, its seeds constitute food for birds such as White-bellied Munia (*Lonchura leucogastra*) and the long leaves are good nesting material for birds like the Baya Weaver (*Ploceus philippinus*) and shelter for smaller creatures to hide in. In addition, the dense root mats of *Panicum maximum* is considered suitable for controlling soil erosion on slopes while providing valuable fodder.

In Kenya, the *Panicum maximum* is found growing naturally in the delta wetland region of Tana River County. The pastoralist communities found in Tana Delta who keeps the following livestock: cattle, sheep, goats, camel and donkeys as their main source of livelihood heavily depend on *Panicum maximum* as the main source of pasture. These herders heavily rely on natural pastures which are often low in quality and supply, and mainly under a free grazing system (Ramadhan et al., 2015). Pastoralists in Tana Delta use this area of *Panicum maximum* as dry-season grazing areas for their livestock (Matiku, 2009). About 20,000 heads of cattle permanently graze at the core of the Delta, but during the dry season the figure rises to 220,000 (Odhengo et al., 2014).

Most pastoralists overstock leading to soil erosion and vegetation degradation; especially around water points (National Environmental Management Authority (NEMA), 2009). Extensive grazing is practiced on the terrace lands and in times of drought, cattle are moved to the lush grasslands of the lower floodplains (Ministry of Lands (MoL), 2012).

The dry season grazing areas covered by *Panicum maximum* is an important part of sustainable grazing cycle. This is because it relieves pressures on the wet season grazing areas, which would otherwise be depleted of pasture during the dry season and subjected to serious environmental degradation.

The land in this area is also communally owned which makes it difficult to enforce effective management practices for *Panicum maximum* on land that is community owned (NEMA, 2009). This situation has led to overexploitation of *Panicum maximum* in the area. Consequently, the resulting overstocking of the grazing areas poses greatest threat for the existence of *Panicum maximum*. Therefore, the study sought to determine the status

of the *Panicum maximum* from 1992 to 2015 in the Tana Delta Sub-County and hence determine the causes of change on status of *Panicum maximum* in Tana Delta Sub-County.

2.0. MATERIALS AND METHODS

2.1 Study Site

Tana Delta Sub-county is found in Tana River County in Kenya. Tana River Delta is a vast patchwork of savanna, seasonally flooded grasslands, forest fragments, lakes and the river itself – tha Tana River from which the place has got its name (MoL, 2012). The Delta is home to diverse human settlements, ranging from nucleated to sparse settlements. The communities living in the Delta are made up of Pokomo - 44%, Orma - 44% and Wardei - 8%, while other ethnic groups, accounts for the remaining 4% (Government of Kenya, 2009). These communities earn their livelihoods as farmers, pastoralists, fishermen, traders and tour guides. The Wardei and Orma are pastoralists. The Pokomo are mainly subsistence farmers who farm along River Tana (MoL, 2012).

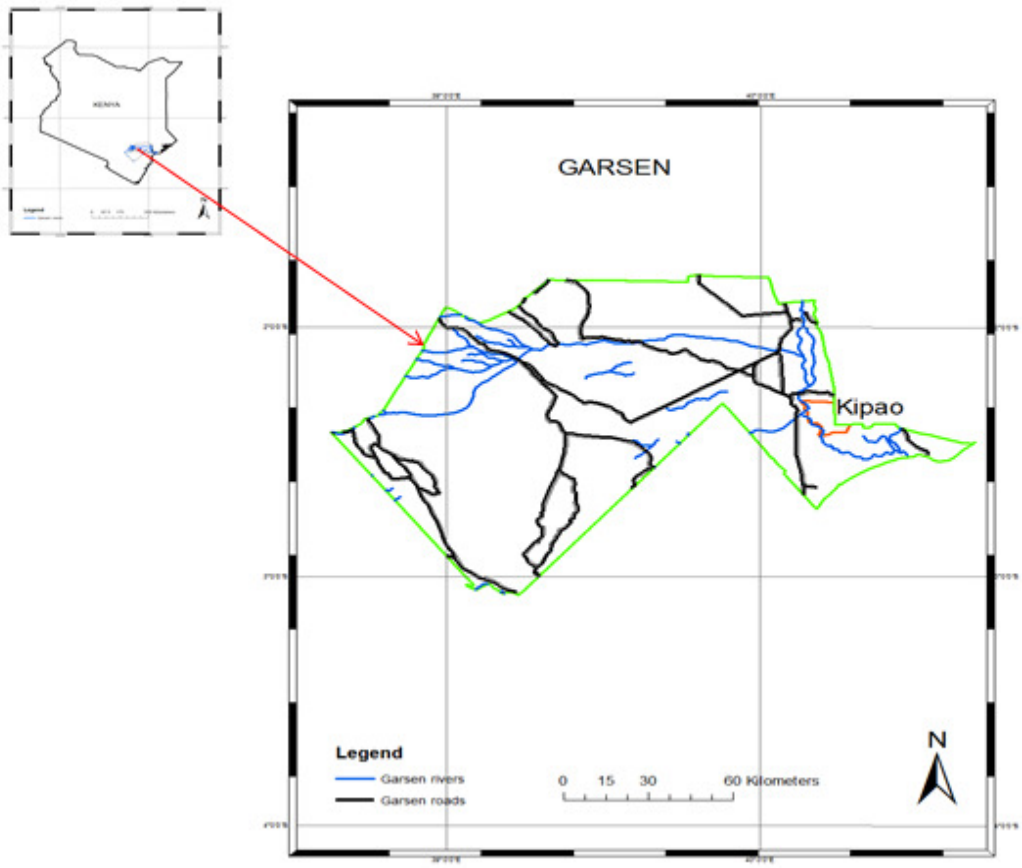


Figure 1: A Map of Kenya (in set) showing the location of the study site (Garsen)

2.2 Research Design

The study used descriptive survey design. The design describes the state of affairs as it exists at present (Kothari, 2004). The design allowed for collection of data in the field using descriptive methods since the main purpose of the study was to identify alternative management practices that can enhance the quantity and quality of *Panicum maximum* as a pasture for livestock rearing in Tana Delta Sub-county.

2.3 Population of the Study

The target population of the study was the entire households in Tana Delta. Population of Tana Delta Sub-County comprising of 18,790 household units. The accessible population comprised of 1,771 household units (Kenya National Bureau of Statistics (KNBS), 2013). This accessible population was drawn from villages that comprise Garsen Central Ward.

2.4 Sampling Technique

A sample of 208 households in the Garsen Central Ward were interviewed. The study used two main sampling technique; purposive and simple random sampling for socio-ecological component. The study selected Tana Delta

Sub-County purposefully because of the presence of large number of livestock and *Panicum maximum* in the region. Simple random sampling was then used to select five villages in the Ward. The households in the villages were also selected using simple random sampling.

2.5 Landsat Image Classification Technique

The images (Plate 4.1, 4.2, 4.3 and 4.4) that were used in the land cover change analysis of the study area were images from 1992, 2000, 2010 and 2015 respectively. These are most appropriate years in terms of quality of the satellite images. Other years have high cloud percentage which makes it difficult to assess the land cover of the study area. The images were downloaded from the USGS website. The 2000, 2010 and 2015 images were those of Landsat[1] 7 while the other was from Landsat 4. Table 3.1 shows more information about the images used.

Table 3.2: Landsat imagery scenes used in the study

Year	Month	Satellite	Clouds cover percentage (%)	Quality	Resolution
2015	January	Landsat 7	20	9	30
2010	January	Landsat 7	2	9	30
2000	January	Landsat 7	8	9	30
1992	January	Landsat 4	10	9	30

The images were analyzed using ArcMap 10.3 and ERDAS (ESRI, 2011). First the area of interest that is the Garsen Central Ward area was identified and a shapefile layer created using the Dataset obtained from International Livestock Research Institute (ILRI) data base by ArcMap. From the downloaded images, band combination was done to visualize the vegetation cover in the study area. The 4,3,2 and 7,4,2 band combination were used and done in ERDAS using the layer staking tool. The images were then clipped to the areas in ArcMap using clipping tool in data management and the masking tool in spatial analyst tool. For 2010 and 2015 images, destripping was done using the destripping tool and focal analysis tool of ERDAS. Unsupervised classification was done to identify the different reflectance areas before the supervised classification was done. The classified images were then opened in ArcMap where map for the land cover was developed.

2.6 Questionnaire Schedule

One set of survey questionnaire was developed and administered to each of the selected household. The questionnaire schedule was used to collect data on the status of *Panicum maximum* in Tana Delta, causes of change of the status of this grass; traditional management practices of *Panicum maximum* and modern pasture management method. All these information obtained from the households by use of survey questionnaire were significant in achieving the objectives of this study.

2.7 Focus Group Discussion Guide

Focus Group Discussion (FGD) guide was prepared and used for group discussion in the field. Two FGDs of 10 members each were held. Membership to the FGD comprised of 4 respondents from each of the five villages in the study area. Village elders with more knowledge on pasture for livestock were selected as members of the FGD. This was done with the support of the ward administrator of the region.

2.8 Data Analysis

Land cover changes between 1992 and 2015 for the study area were determined by analyzing Landsat imagery scenes of the area for the 23 year period. This involved interpretation of spatial and temporal data for different time periods to determine changes in the land cover as a result of land use change by use of remote sensing data. Unsupervised classification system was used to identify the different land covers of the area with focus on *Panicum maximum* cover in the area.

The collected data were analyzed descriptively. Descriptive analytical tools were used to organize, summarize, interpret and present research findings in relation to this study objective. Correlation analysis was also done to determine the relationship between the amount of rainfall and the reduction in the area covered by *Panicum maximum*. These analyses were done using Microsoft Excel and Statistical Package for the Social Science (SPSS).

3. RESULTS

3.1.1 Status of Panicum maximum in Tana Delta

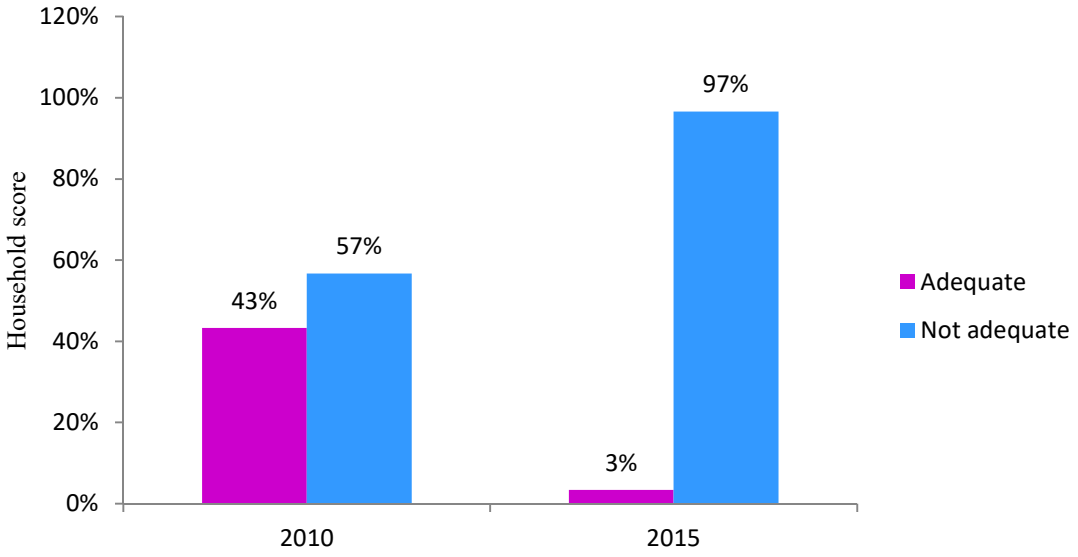
Objective one sought to establish the status of *Panicum maximum* in Tana Delta region. The respondents were asked on the status of the *Panicum maximum* in the 2015 and to recollect their memories in the past five years and

[1] Landsat is an Earth observation satellite series that uses remote sensing to take images of the world's landmasses from space using sensors/radiometers that passively measure electromagnetic energy reflected and emitted from the Earth's surface and transmitted through the atmosphere.

accompanying effects of amount of *Panicum maximum* on cattle productivity. The selection of past five years ago was informed by ability of respondents to easily remember the five years than the 23 years ago (period of satellite images data collection).

3.1.2 Status of the Panicum maximum in Present and Five Years ago

The respondents were asked questions on the status of *Panicum maximum* at present and five years ago. The results are presented in Figure 2.



Social perception on the adequacy of *Panicum maximum* in Tana Delta

Figure 2: *Panicum maximum* adequacy at present and five years ago

The study findings indicate that 97% of the herders stated that the quantity of *Panicum maximum* is not adequate to graze their livestock at present while 57% of the respondents stated that *Panicum maximum* was not adequate in 5 years ago.

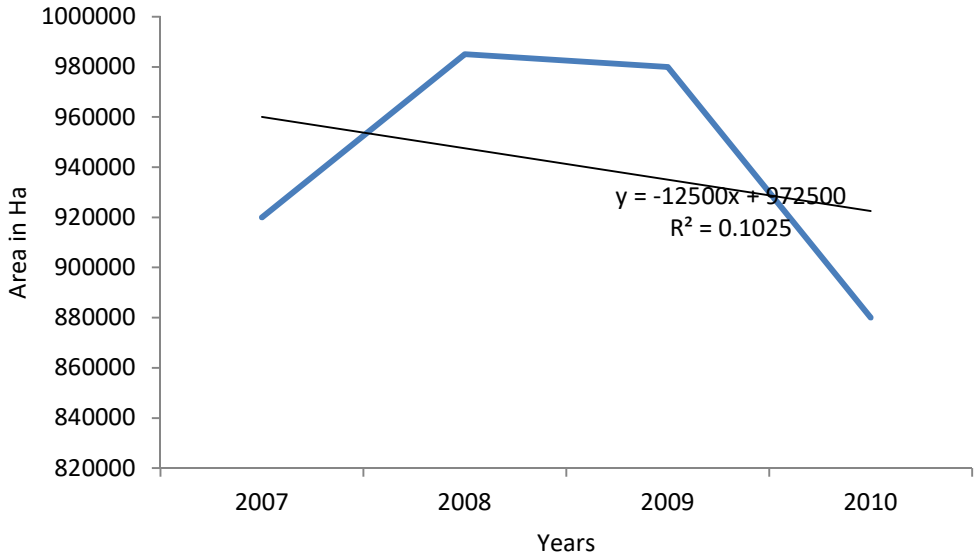


Figure 3: Natural pastures coverage in Tana Delta from 2007 to 2010 (Source: Ministry of Livestock Development, 2010)

3.2 Satellite Image Analysis for the Study Area

Satellite image analysis was done to confirm whether the grass has increased or decreased in the Tana Delta region as shown in Plates 1, 2, 3, and 4.

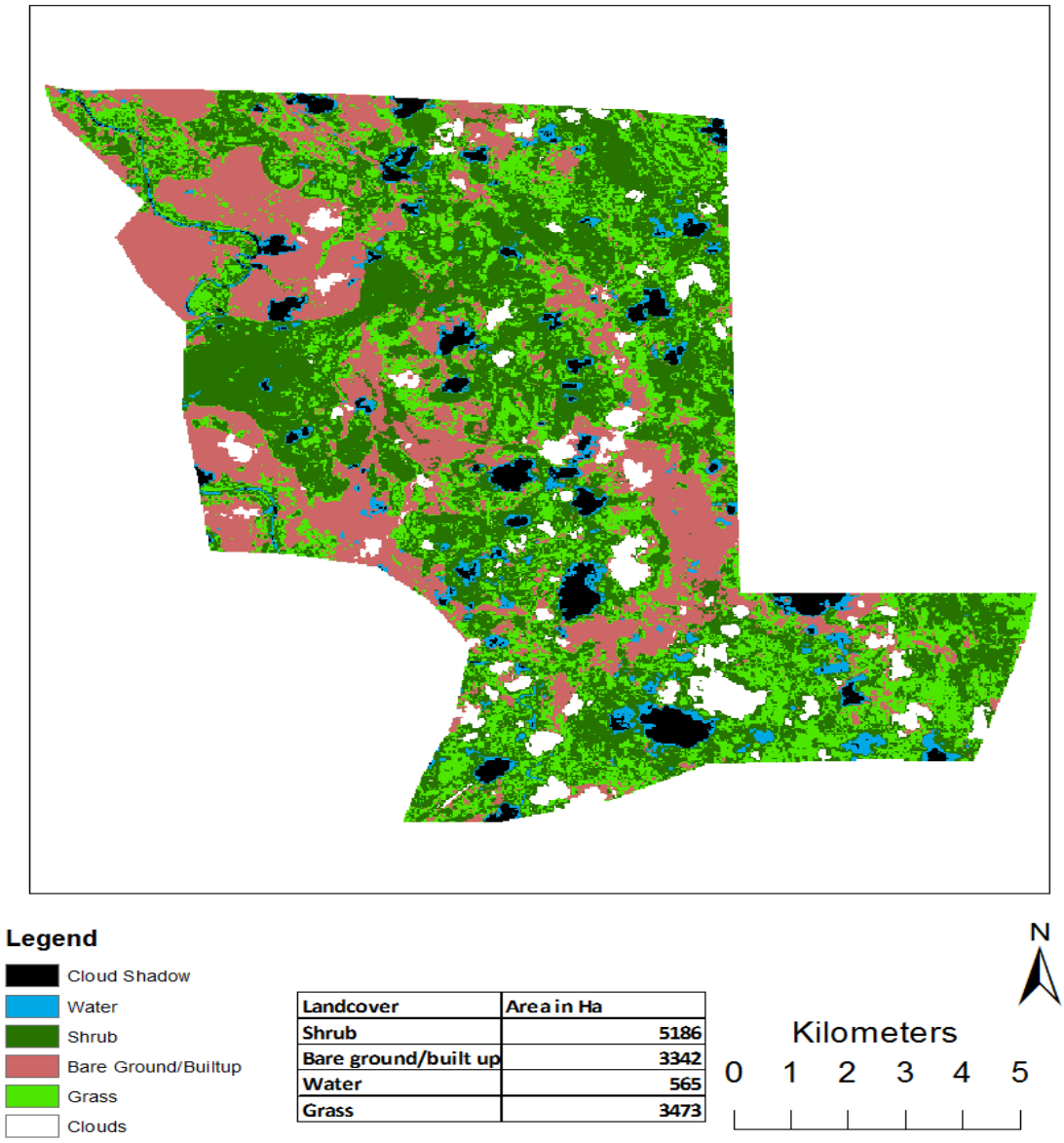
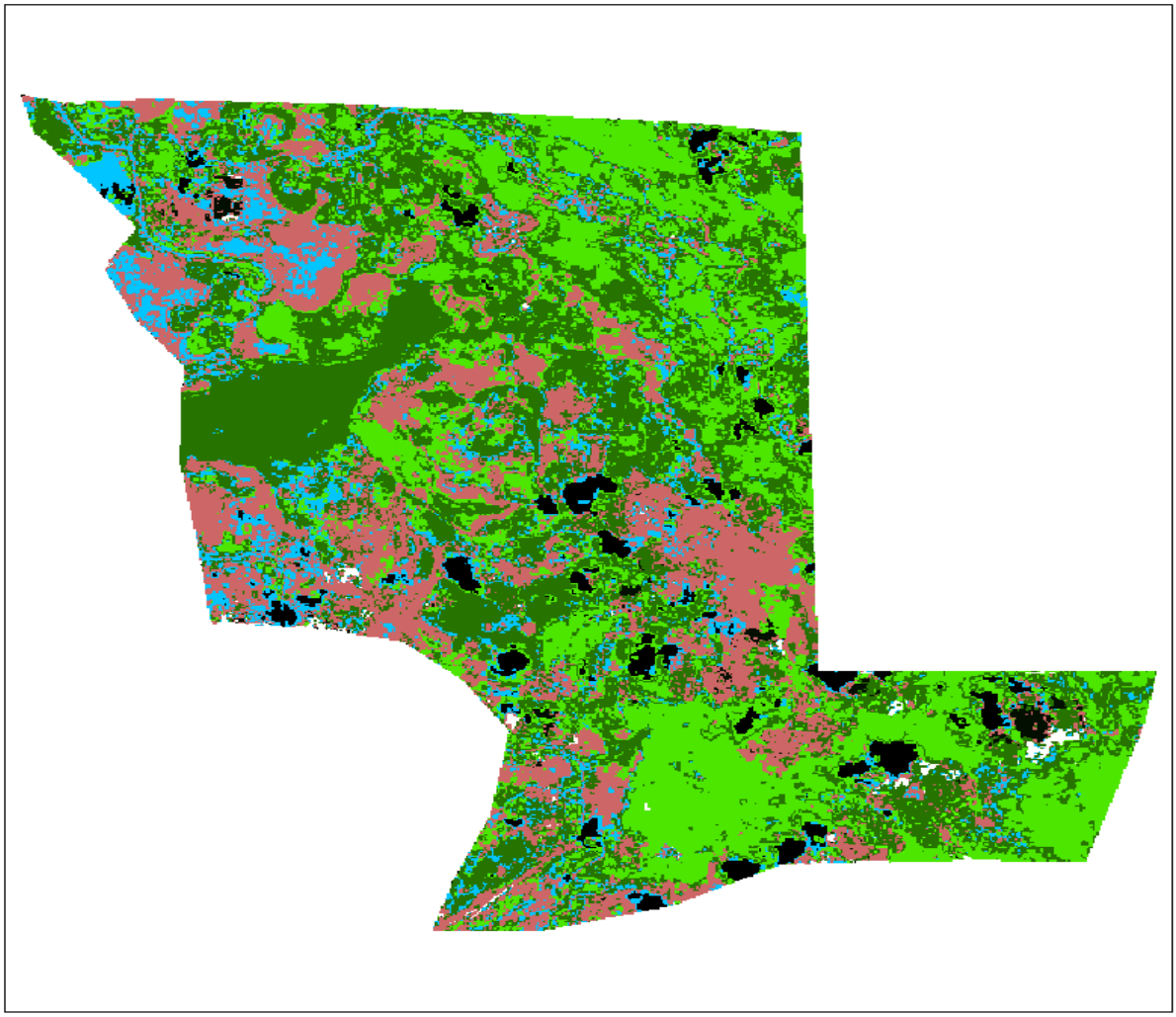
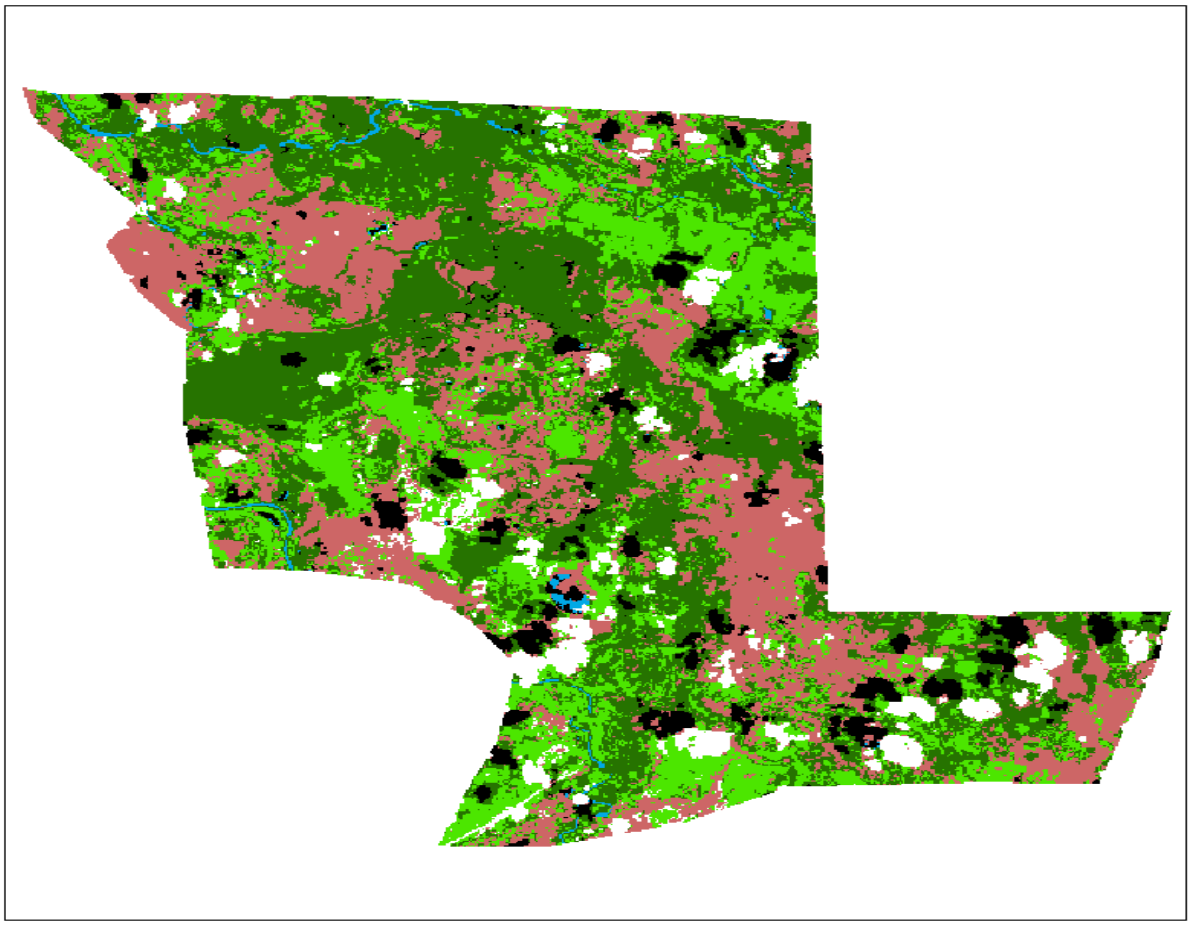


Plate 1: Land cover image of 1992 in Garsen Central Ward



Landcover	Area in Ha
Shrub	4164
Bare ground/built up	2658
Water	1212
Grass	4160

Plate 1: Land Cover change image of 2000 in Garsen Central Ward



Legend

- Cloud Shadow
- Shrub
- Water
- Bare ground/Builtup
- Grass
- Clouds

Landcover	Area in Ha
Shrub	5269
Bare ground/built up	3621
Water	112
Grass	3186

N

Kilometers

0 1 2 3 4 5

Plate 2: Land cover change image of 2010 in Garsen Central Ward

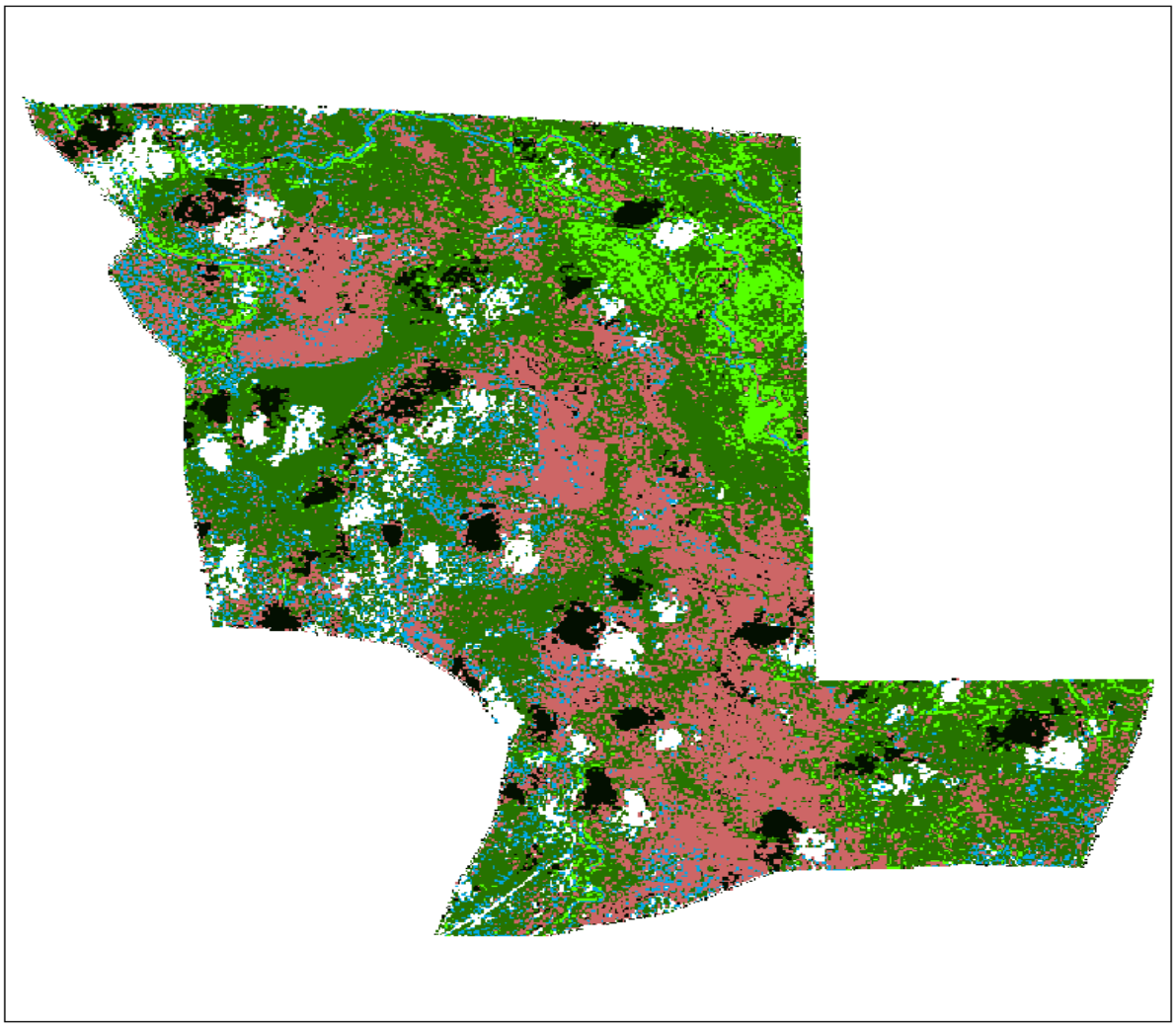


Plate 3: Land cover change image of 2015 in Garsen Central Ward

Table 1: Land cover changes in study area, 1992 to 2015.

	Area in Ha			
Land cover/year	**1992**	**2000**	**2010**	**2015**
Shrubs	5186	4164	5269	6440
Bare ground/built up	3342	2658	3621	3509
Water	565	1212	112	861
Grass	3473	4160 (+20%)	3186 (-23%)	947 (-70%)

From the Plates (1, 2, 3 and 4) and Table 1, it is evident that the grass coverage has reduced from 1992 (3473 ha) to 2015 (947 ha) which represents 73% decrease. Therefore, the result from this analysis correlates with the questionnaire data that the grass coverage has reduced. The grass coverage was observed lowest in 2015 (947 ha) and highest in 2000 (4160 ha). In 2015 the bare ground/built up area and shrub land covers were the most dominant land cover type in the area. The area covered by shrubs was also observed to increase over the years. The reduction

of the grass can be explained by the successions of grass areas with these shrubs. Furthermore, the rainfall the area receives in recent years was observed low which might have resulted in the decline of area covered by this grass.

3.3 Effects of amount of *Panicum maximum* on Cattle Productivity

The respondents were asked question on how *Panicum maximum* quantity affects the productivity of cattle in Tana Delta region. The responses were captured in Figure 4.

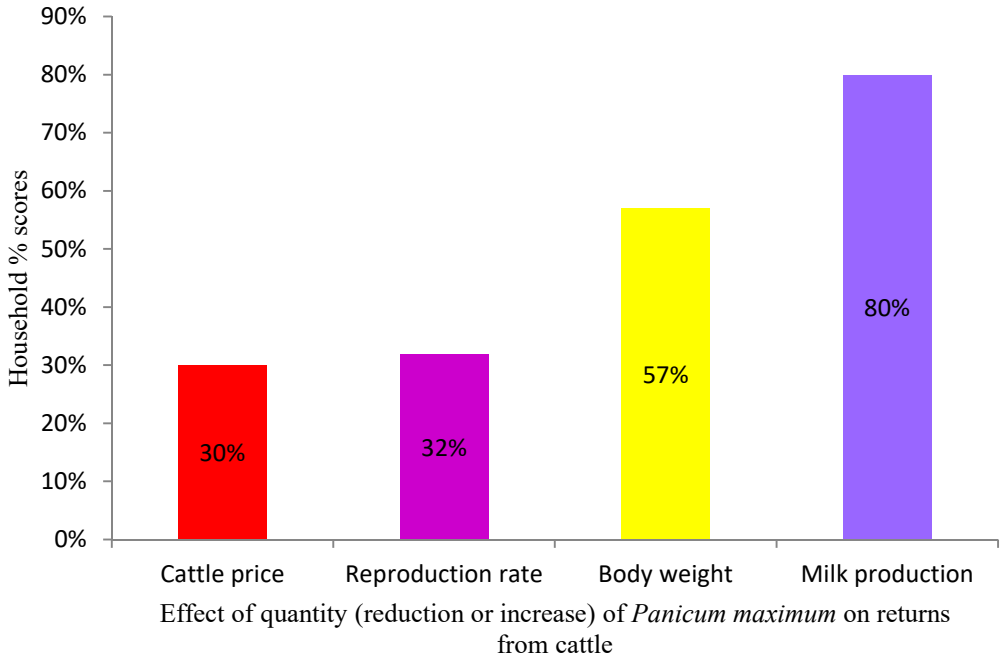


Figure 4: Effect of quantity (reduction or increase) of Panicum maximum on returns from cattle

Four fifth (80%) of the respondents stated milk production as one of the factor being affected by *Panicum maximum* quantity while over half (57%) of the respondents mentioned reduction in body weight as one of the factor affected by quantity of *Panicum maximum*.

3.4 Causes of Change on Adequacy of Panicum maximum in Tana Delta

The respondents were asked question on the causes of change on status of *Panicum maximum* and the results are presented in Figure 5.

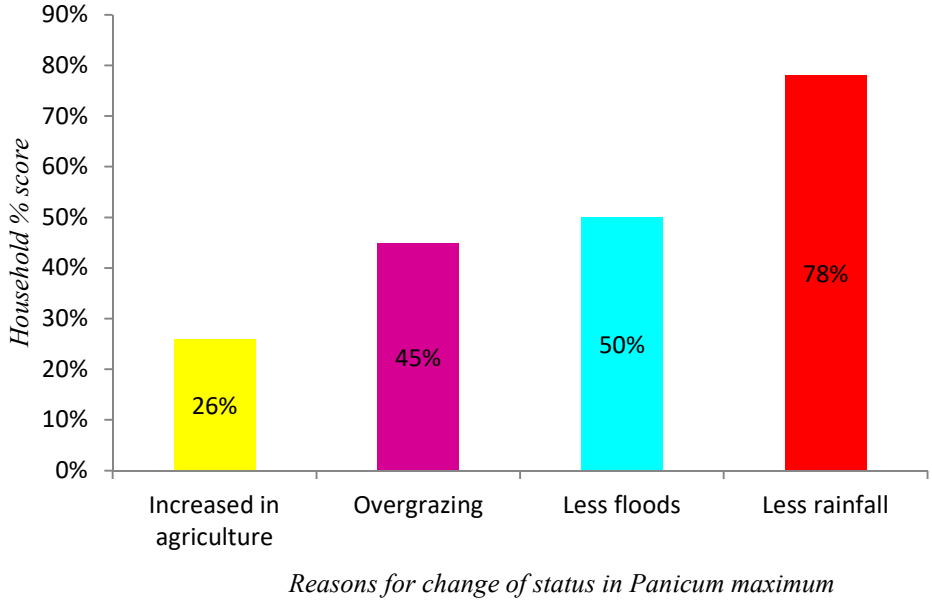


Figure 5: Causes of change on adequacy of Panicum maximum in Tana Delta

From Figure 5 it is clear that over three fourth (78%) of the respondents stated that the decline of *Panicum maximum* in Tana delta was caused by low rainfall the area receives.

4.0 DISCUSSIONS

Majority of the respondents asserts that *Panicum maximum* was not adequate for their cattle in both 2010 and 2015. The study finding is in agreement with the study done by Ministry of Livestock Development (2010) who observed a reduction in area covered by the natural pastures in Tana Delta.

The reduction in the grass cover can be attributed to many factors such as grazing intensity, climate changes and succession of other plant species. The increase in number of livestock that depends on *Panicum maximum* in Tana Delta region might be the main cause of the grass decline. Grazing intensity has a major impact on range condition. In a study by Kiarie (2014), it was noted that overstocking of the cattle in the grazing areas could cause vegetation losses in the area. In addition, FAO (1997) also acknowledges that prolonged heavy grazing undoubtedly contributes to the disappearance of palatable species and subsequent dominance by other, less palatable, herbaceous plants or bushes. FAO (1997) goes on to posit that excessive livestock grazing also causes soil compaction and erosion, decreased soil fertility and water infiltration, and loss of organic matter content and water storage capacity.

This implies that the reduction in the quantity of *Panicum maximum* negatively affects cattle performance in milk production and body weight maintenance. The finding is supported by Ayanda (2013) who observed that the pastoral Fulani of Nigeria believes that cattle reproduction depends on the quantity and quality of the grass. This argument is in line with the perception of pastoral communities in Tana Delta Sub-County that less pasture leads to reduction of reproduction rate of the cattle. In addition Ojo et al. (2013) notes that livestock production is limited by the availability of grazing resources in terms of quantity and quality in meeting the nutrient requirement of the livestock. This low cattle productivity may have negative economic effects on the livelihoods of the pastoral communities in Tana Delta region.

The finding on the causes of reduced *Panicum maximum* is in line with that of Nunow (2010) who affirmed that the rainfall in the region is erratic and unreliable in recent years. For example, NDMA (2014) notes that the December 2014 rainfall was only 9% of the total average rainfall for this period of the year, which is an absolute deficit of 161 mm. As observed in Figure 6 the amount of rainfall in Tana Delta has been on decline since 2011 to 2015 causing the decrease in the grass coverage in the region. The reduction on quantity of the grass is because of the reduction of total rainfall received over the last 5 or so years. This is further supported by work done in Kilifi, Budalangai and Meru by Okeyo & Wamugi (2018) in which they assert that climate change has played a part in reduction of livestock productivity by hampering growth of feeding materials, different species of grasses included.

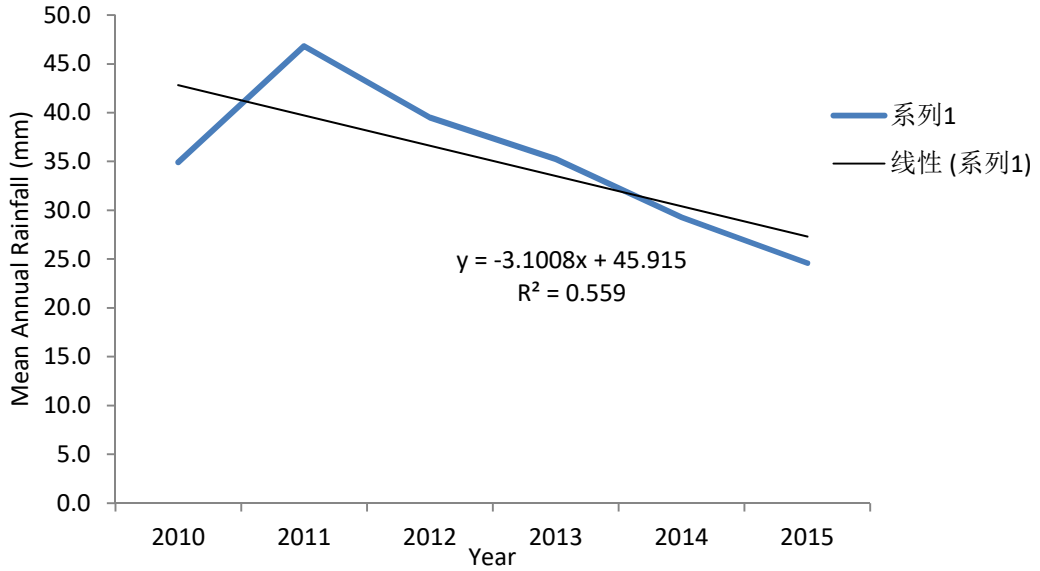


Figure 6: Mean annual rainfall (mm) of Tana Delta. (Source: National drought management authority (2014), Ministry of livestock development (2010), Ministry of agriculture DAO Tana delta (2012)

The decrease in amount of rainfall has been caused by the global climatic changes which causes reduction in pastures in the region. The reduction of the amount of rainfall in the Sub-county has caused reduction in pasture grasses particularly *Panicum maximum*. Figure 7 also indicate strong relationship (R^2=0.7388) between amount of rainfall in Tana Delta and the grass coverage. This means that as amount of rainfall increases the grass coverage

also increases and decrease in rainfall also causes decrease the grass coverage. The reduction of pasture has a negative effect on the performance of cattle in Tana Delta that depends on natural pasture.

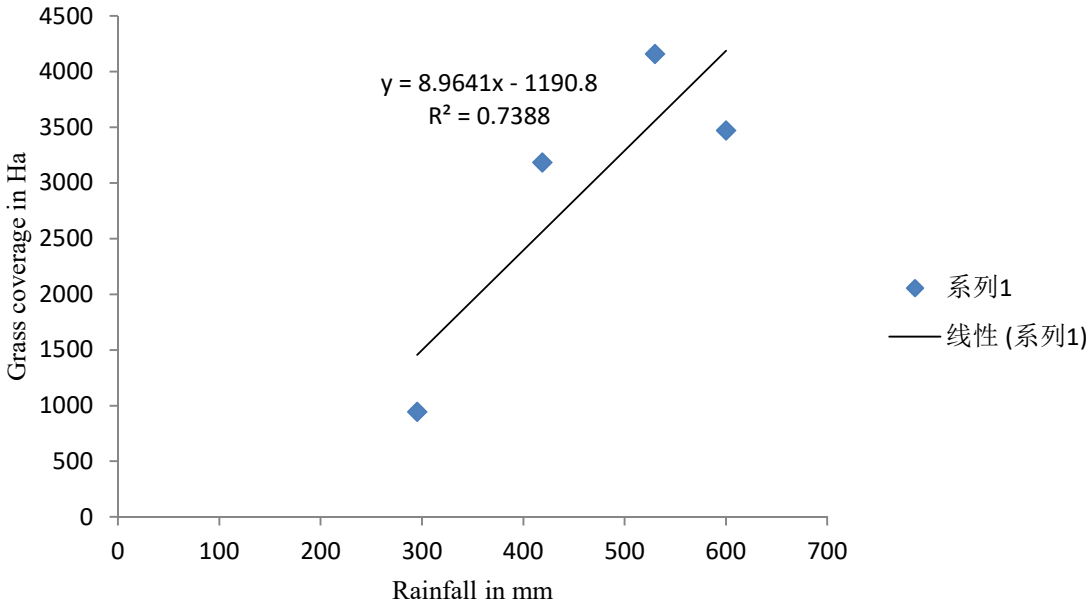


Figure 7: Relationship between amount of rainfall and grass coverage in Ha

Some of the respondents cited increased in number of animals grazing in Tana delta areas as being the factor that causes depletion of the grass in the region (Figure 5). The increase in number of livestock in Tana Delta region causes overgrazing in the region. Increase in human population ensued increased in number of livestock in Tana Delta. This together with the incursion of livestock from neighboring counties like Garissa and Lamu counties puts more pressure on pasture resources particularly *Panicum maximum* in Tana Delta. Consequently, the natural pasture resources (*Panicum maximum*) are now constrained due to increase in number of livestock in the region that puts more pressure on it. The respondents have indicated that the price per cattle go up therefore, respondents have invested more in cattle. The cattle are bought from other regions such as Kitui and Garissa Counties thus additionally increasing the actual number of livestock in the region. This was revealed during Focus Group Discussion (FGD) on the causes of increased in number of cattle in Tana Delta.

The finding of this study is supported by the study done by Oba and Kotile (2001) who acknowledge that human and livestock demographic growth has contributed to decline in range productivity. Further research by Oba (2012) shows that the delta is highly overgrazed due open to all pastoralists. Ministry of Livestock Development (2010) also cited increase in cattle population in Tana Delta region as illustrated in Figure 8.

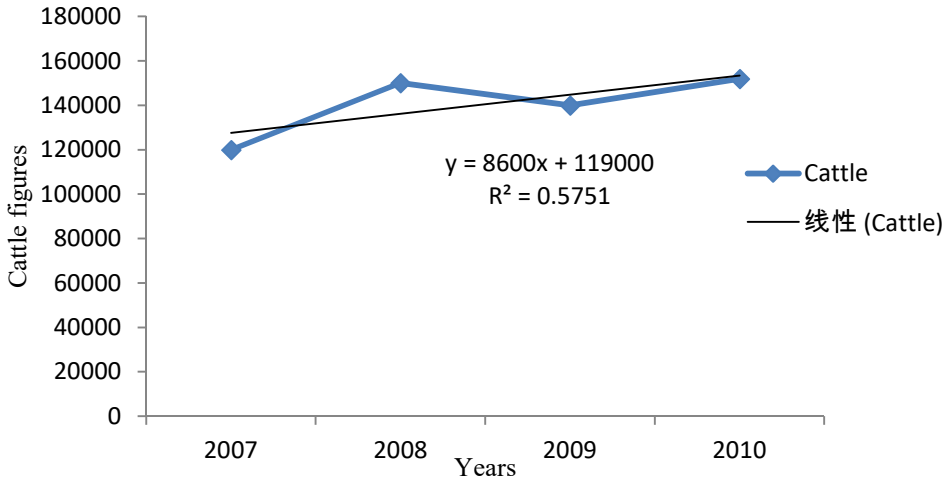


Figure 8: Trend of cattle population in Tana Delta from 2007 to 2010 (Source: Ministry of Livestock Development (2010)

From Figure 8 it is evident that there is an increase in number of cattle from 2007 to 2010. This is due to the cattle staying in delta longer and some stay permanently. Tana delta is used by the Orma and fellow pastoralist communities from the surrounding region as a pasture land. There is large concentration of cattle from the Tana River County within the delta. Finding agrees with that of Leauthaud (2013) who found out that tens of thousands of livestock converge to the delta all the way from the Somali border, Garissa and Tsavo East National Park.

Increase in number of cattle grazing in the same areas has negative effects on the production and sustainability of pastures in the region. The finding is in line with those of Jones (2002) who notes that increase in number of cattle in the grazing areas results to disappearing of vegetative species from ranges due to inability to regenerate itself and be replaced by unpalatable weeds, thorny shrubs and unproductive woodlands.

5.0 CONCLUSION

From the findings, the study concludes that the quantity of *Panicum maximum* is low. Several factors have caused the low quantity of this natural pasture. The reduction in amount of rainfall the area receives has caused the reduction of *Panicum maximum*. In addition, overstocking of cattle in the communal grazing areas has resulted in overgrazing thus reduction of the grass.

Acknowledgments

KCDP, Pwani University, Supervisors, Department of Livestock production Office, Tana Delta and Local Community

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