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Socio-Economic and Climatic Factors that Influence Pastoralists' Perception on Natural Rangel and Resources in Butana Area, Sudan

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ABSTRACT

Semi-arid areas cover a large part of the Earth's surface. They are characterized by low and highly variable precipitation. Livestock grazing is the predominant type of land use, providing livelihood for more than a billion people. Yet, income from livestock grazing is associated with large uncertainties, as productivity of the pastures depends strongly on the low and highly variable precipitation (Behnke et al. 1993, Sullivan and Rhode, 2002).Droughts and shortage of rainfall devastated the area during the last three decades of the past century. Misuse of land including, over-grazing, expansion of agriculture and cutting of trees, led to deterioration of natural rangeland resources in the area manifested in observed changes in vegetation cover and range plants' botanical composition. This study aimed to identify some socio-economic and climatic factors that influence pastoralists' perception on the condition of natural rangeland resources. A random sample of 407 pastoralists' households in Butana area was chosen to collect primary data. Both descriptive statistics and econometric model were used for data analysis. Logit model was employed to identify the socioeconomic factors that influence pastoralists' perceptions towards natural rangeland resources. There was a negative influence relationship between dry season and condition of rangeland, but the coefficient was not statistically significant. A negative and significant relationship was found between herd size (number of heads) and condition of rangeland. There was negative and significant relationship between soil erosion and improved rangeland. On the other hand negative relationship was found between expansion of agriculture and improved rangeland, but the coefficient was not statistically significant.

Keywords: *Natural rangeland, drought, overgrazing, expansion of agriculture, soil erosion, land degradation, desertification.*

1. INTRODUCTION

The area of the Sudan is about 1,882,000 km^2, with a population of 33,419,625 (Ministry of Information, 2011). The country is characterized by diverse ecological zones resulting from interaction among a number of complex interrelated factors such as climate, soil types, geological formations and human acivities. The variations of rainfall coupled with differences in soil types are responsible for the diversity of vegetation cover not only in its species composition but also in the size and density of plants (Harrison and Jackson, 1958). Livestock population is about 103,570,493 heads (MARF, 2011). About 90% of animal production in Sudan is from rangeland (Fadlalla and Ahmed, 1997). Plate (1) shows the open rangeland of the study area (Butana area). Range condition and trend assessments over the years have often pointed at worsening productivity of natural pastures both in the arid and semi-arid areas of East Africa (McPeak, 2001 and Coughenour, 2004).

A considerable number of Sudan's households keep livestock, with perhaps one third to one half of all households depending on livestock for their livelihood. Most livestock producers in the Butana are transhumant or sedentary farmers who maintain herds but also engage in crop production and/or wage labour. Livestock and livestock products generally meet domestic demand and supply an export market focused on Saudi Arabia and Gulf countries (IGAD, 2007). The main livestock in Sudan are cattle, sheep, goats, camels, donkeys and horses. Livestock are vital to the welfare of large numbers of Sudanese by serving as a source of food, store of wealth, source of revenue, mode of transport, and draft for crop farming. Livestock are also central to the identities and beliefs of many Sudanese tribes (IGAD, 2007). The Butana corresponds to a socio-ecological unit under 5 states and 9 locality divisions and it covers an area of 65000 km^2. The word Butana is derived from the Arabic word 'buton', meaning belly in English. It refers to the region between the River Nile, Blue Nile and the River Atbara and the Khartoum, El Gadaref and Kassala railways as the southern boundary. Figure (1) shows Butana Plain, (IFAD, 2009). It is inhabited by 3 groups: (i) a group that resides all year round in the central Butana but practices seasonal labour migration as a coping strategy whereby men migrate to the periphery of Butana in the dry season in search of work in the irrigated and mechanized schemes or migrate to Khartoum where they work in the building industry, brick making and petty trade; (ii) a group who settled in the periphery of the Butana - particularly on the outskirts of the New Halfa irrigation scheme - in the wake of the 1980s drought and who returns to Butana in the rainy season to cultivate own land in wadis or on terraces; (iii) the nomadic group who moves to Butana from nearby states in the rainy season to make use of the open access pastures (IFAD, 2009). The main source of income/livelihood is subsistence oriented and is based on pastoralism and traditional agriculture. Traditional agriculture depends essentially on harvesting of rain water through terrace and wadi (seasonal water course) cultivation. Terrace cultivation involves the establishment of ridges to reduce rain water run-off and increase soil moisture content. Wadi cultivation is practised on the residual moisture following the

recession of wadi or seasonal river floods. Sorghum is almost the sole crop grown. Pastoralism entails migration to Butana during the rainy season and out of the Butana during the dry season to areas where crop residues and water are available. This means that herds move to New Halfa and Gezira Schemes, as well as to the large-scale mechanized schemes in the states of Gadaref, Blue Nile and River Atbara and further south towards Upper Nile State in Republic of South Sudan. Goats are sold all year round to meet consumption needs, whereas sales of camels/ cattle and sheep are seasonal.

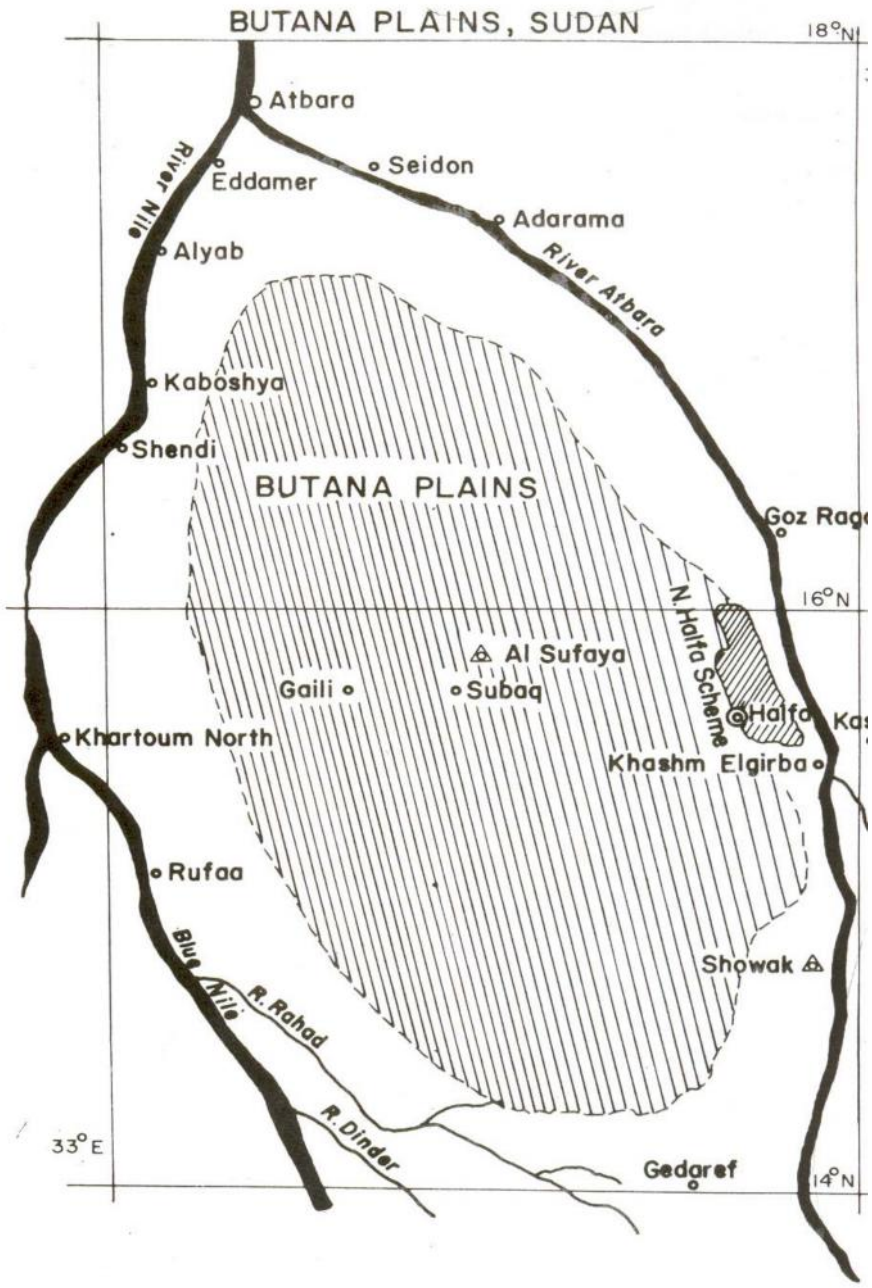

Fig 1: Map showing Butana Plain, Sudan
Source: Mohammed, (1999)

Plate 1: The open rangeland of the Butana
Source: author's field survey 2011

1.1 Research Objective

The overall objective of the research was to identify the socio-economic and climatic factors that influence pastoralists' perceptions on natural rangeland resources.

2. MATERIALS AND METHODS

The sampling frame for pastoralists was defined according to the equation of (Cochran, 1977) considering pastoralists' number as per the 5th Sudan Population and Housing Census-2008. A field survey was conducted during Septemper 2011, by visiting Centeral Butana area and livestock watering points, which are sites used by pastoralists. Pastoralists reach Butanaa from different states to search for forage and water. The main tribes of pastoralists are Shukriya, Batahin, Khawalda, Dileigab, Bishariyn, Lahawin, Arakiyin, Rashaida, Fadnya, Magharaba, Hadandawa, Baniaamer and Ruffaa. A random sample of 407 pastoralists' households in Butana area was chosen to collect primary data. Both descriptive statistics and econometric model were used for data analysis. The logit model was introduced by Joseph Berkson in 1944, who coined the term. Logit model is a model which uses regression technique for the analysis (Alamin et al. 2012). This model estimates the probability that an event occurs or not by predicting a binary dependent outcome from a set of independent variables. Logit model can also be called logistic model. The basic difference between Logit and Probit models is that Logit assumes a cumulative logistic distribution, while Probit model assumes cumulative normal distribution. The logit model was chosen because the properties of estimation procedures are more desirable and it is computationally easier than the Probit to evaluate the rangeland indicator (Pindyck and Rubinfeld, 1991, Miller and Franklin, 2002). In the logit regression model, parameters are determined through maximum likelihood estimation (MLE) procedure (Joseph et a., 2006: Yazan et a., 2012). In logistic regression the fitting is carried out by working with the logit. The odds ratio is a measure of effect size, describing the strength of association or non-independence between two binary data values. It is used as a descriptive statistic, and plays an important role in logistic regression. Unlike other measures of association for paired binary data such as the relative risk, the odds ratio treats the two variables being compared symmetrically, and can be estimated using some types of non-random samples (Rebecca, 2007).

3. RESULTS AND DISCUSSION

Description of the variables used in the models:

Table 1: Definition and expected signs for dependent and independent variables incorporated in the econometric analysis (logit model)

Dependent variable		**Expected sign**
Rangeland condition	Dummy	
Independent /explanatory variables		
Dry season	Dummy	-
Age (years)	Continuous	+
Opening of fire lines	Dummy	+
Soil erosion/ degradation	Dummy	-
Period of rainy season	Continuous	+
Expansion of agriculture on the rangeland	Dummy	+/-
Herd size	Continuous	+/-
Reseeding	Dummy	+

Table 2: Descriptive statistics for dependent and independent/ explanatory variables

		Frequency	**Percent**
Rangeland condition	Improved	81	19.9
	Otherwise	326	80.1
Open fire lines	If open	211	51
	Otherwise	196	48.2
Soil erosion/ degradation	If erosion	322	79.1
	Otherwise	85	20.9
Expansion of agriculture on rangeland	If expansion	314	77.1
	Otherwise	93	22.9
Reseeding	If reseeding	215	52.8
	Otherwise	192	47.2
Season	Dry	359	88.2
	Otherwise	48	11.8
	Mean		Std. Deviation
Age (years)	37.79		12.201
Number of rainy days	21.19		7.063
Herd size (head)	54.41		24.886

Table 3: Logistic regression results for explaining the socio-economic and climatic factors that influence pastoralists' perception on natural rangeland resources

Dependent variable	**Rangeland (Improved = 1, Otherwise = 0)**				
In dependent variable	Coefficient	Odds ratio	Std. Error	z	P-Value
Season (dry =1, otherwise = 0)	-.6233605	0.53614	.4705355	-1.32	0.185
Age (years)	.0266822	1.027041	.0107932	2.47	0.013
Open of fire lines (if open=1, otherwise = 0)	1.152515	3.166146	.346586	3.33	0.001
Soil (erosion = 1, otherwise = 0)	-1.209331	0.298397	.4309989	-2.81	0.005
Number of rainy days	.0101494	1.010201	.005275	1.92	0.054
Agriculture (ha) (Expansion = 1, otherwise = 0)	-.1180941	0.888612	.3292674	-0.36	0.720
Herd size (head)	-.0298929	0.970549	.0179489	-1.67	0.096
Reseeding	.077839	1.080949	.2648785	0.29	0.769
Constant	-2.319196	0.098353	.6427419	-3.61	0.000
Prob > chi2 = 0.0000					
Log likelihood = -184.83077					
Pseudo R2 = 0.0900					
Number of obs = 407					

Logistic analysis is conducted to analyze factors affecting pastoralist perceptions towards rangeland resources condition in Butana area in the Sudan. Variables used in the model were age , season, opening of fire lines, soil erosion/ degradation, number of rainy days, expansion of agriculture on the rangeland, herd size and reseeding. STATA software 10.1 was used to analyze the data. The result shown in Table (3) for the logit model presented the estimated coefficients (values), standard error, and significance values and odds ratios of variables in the model. Binary logistic regression is used where dependent variable is dichotomous. According to Gujarati (1992), the coefficient values measure the expected change in the logit for a unit change in the corresponding independent variable, other independent variables being equal. The sign of the coefficient shows the direction of influence of the variable on the logit. It follows that a positive value indicates an increase in the likelihood that a household will change to the alternative option from the baseline group (Gujarati, 1992; Pundo and Fraser, 2006). The results show that out of the eight explanatory variables which were hypothesized to affect perception of pastoralists' on natural rangeland resources and which in turn affect the outcome, only five variables were found to be statistically significant. These include age, dry season, opening of fire lines, soil erosion/ degradation, number of rainy days and herd size.

Age of pastoralists was found to be positive and significantly correlated with perception towards rangeland condition. The positive relationship maybe explained by experience and skills gained from families. The mean age of 37 years also reflect vitality and ability to manage herds. Older household heads, the decision makers in the household, will decide to keep livestock. A negative and significant relationship was found between herd size (number of heads) and condition of rangeland. The explanation of this relationship could be that with increased herd size, overgrazing affect rangeland condition. The value of the odd ratio (0.97) supports the higher probability of the variable influencce on the rangeland. In many regions of the world livestock rely on extensive grazing of marginal rangeland vegetation resources in ecosystems which are assumed to be highly vulnerable to overexploitation and therefore degradation (Lamprey, 1983; Heady and Child, 1994; Pickup et al. 1994, Johnson (1992) and Platts (1991) and EARO, 2002). This has been the subject of vigorous debates (Ellis and Swift, 1988; Behnke and Scoones, 1993; Sullivan and Rohde, 2002; Vetter, 2005).

Butana is very rich in its natural resources, but lacks permanent sources of water (Elsadig et al, 2008). The number of rainy days had a positive and significant influence on the rangeland. Increase of the number of rainy days would increase the likelihood of improved range condition.

There was a negative and significant relationship between soil erosion and improved rangeland. Clearly soil erosion causes degradation, incidence of soil erosion would decrease probability of having improved rangeland. A compaction layer is a near surface layer of dense soil caused by the repeated impact on or disturbance of the soil surface. Compaction becomes a problem when it begins to limit plant growth, water infiltration (Willat and Pullar 1983, Thurow et al. 1988) or nutrient cycling processes (Hassink et al.1993 and Amaha).

Fires play an integral role as a disturbance throughout most of the rangelands (Gill et al. 2002, Gill and Bradstock, 2003). A positive and significant ($P<0.001$) relationship was found between open fire lines and improved rangeland condition. Management can affect fire regimes through alterations to rates of ignition and spread of fires via prevention and suppression activities (TSMCRC, 2004).

It was expected that reseeding could have positive influence on the rangeland, but the coefficient was not statistically significant. Broadcasting is necessary to reseed areas that have soil disturbance. On the other hand a negative relationship was found between expansion of agriculture and improved rangeland condition, but the coefficient was not statistically significant.

A negative relationship was found between dry season and improved rangeland, condition, but the coefficient was not statistically significant. This is probably a result of the low and erratic rainfall. Forage growth and distribution in semi-arid rangelands is driven by precipitation and tends to be highly variable intra-annually (Rutherford, 1978), inter- annually (Ellis and Swift, 1988) and spatially (Bayer et al, 2004).

4. CONCULOSION

Rangeland resources play an important role in the livelihoods of pastoralists in Butana area. Management of rangeland through opening of firelines, control of erosion is important for maintaining range condition as reflected from pastoralists' perception towards improved rangland condition. Adaptation options to climate variability especially rainfall such as water harvesting techniques and matching herd size with carrying capacity will also help in reducing pressure on rangeland resources and polices are needed to encourage pastoralists to control the number of animals kept by improving marketing facilities and access to animal producers.

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