

Assessment of Land Degradation at Velezizweni, Swaziland

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Abstract: The objective of the research was to determine the status of land degradation and its implications for Velezizweni community, an area situated in the Highveld of Swaziland. Landsat ETM digital data taken on December 2009 was used to classify the land into different land cover categories. A questionnaire was developed and administered to 190 homesteads to solicit information on perception of land degradation from land users. About 19% of the area was classified as eroded, with about 45% classified as having poor vegetation cover. Land degradation was perceived as a serious problem by 81 and 90% of the respondents on cropping land and communal grazing land respectively. Invasion of alien plant species (*Chromolaena odorata* and *Acacia pycnatha*) was a serious problem, reducing the carrying capacity of grazing land. The results demonstrated that degradation was a serious problem despite the community being involved in some sustainable land management practises which included application of kraal manure to crops, ploughing across the slopes and keeping grass filter strips between cultivated lands.

Keywords: Bush encroachment, land cover, land degradation, soil conservation, soil erosion

INTRODUCTION

Land degradation and its effects: Land degradation is defined as a reduction in the capacity of land to perform ecosystem functions and services that supports society and development (LADA, 2009). It is estimated that about 55% of the communal land in Swaziland suffers from some form of land degradation (Manyatsi, 1997). The dominant forms of land degradation in the country are soil degradation, vegetation and biodiversity degradation, with soil erosion being the most visible form of soil degradation (Manyatsi and Maseko, 2010). Studies have shown that gully densities as high as one for every 5 km² are found at some areas and that the problem has increased as a result of overexploitation and unwise use of land resources (Mushala, 2000; Morgan and Mngomezulu, 2003).

The main causes of land degradation in Swaziland can be divided into three groups; socio economic conditions, rangeland and livestock management and direct human interference (Stringer and Reed, 2006). The socio economic factors include problems associated with high population pressure that leads to increased competition for natural resource base. It also includes the traditional attitude of keeping cattle in large numbers leading to high stocking rates and low productivity. On the other hand the range and livestock

management factors include unsustainable stocking rates that lead to overgrazing and vegetation depletion and the inappropriate and uncontrolled burning of rangelands, leading to vegetation degradation. The direct human interference includes inappropriate locations of settlements that results to damage to the environment, degradation of cultivated lands that leads to depletion of soil fertility and deforestation.

Land degradation deprives poor people of the most environmental services on which they must depend. For example, degraded land can no longer produce crops, provide forage for livestock, provide wood for fuel, or provide healthy and sufficient water. An improved understanding of its causes, impacts and degree together with the understanding of perceptions of land users on land degradation is critical towards its control.

Assessing land degradation: Soil erosion has been given more attention in Swaziland as it is the most visible form of land degradation in the country (Jansen *et al.*, 1994). Erosion hazard was mapped by Nkambule *et al.* (1989) using the Soil Loss Estimation Method for Southern Africa (SLEMSA). The SLEMSA comprises a factorial scoring approach taking into account rainfall erosive, soil credibility, slope, vegetation cover and human population density. An erosion hazard map showing the likelihood of erosion in the different parts

of the country was produced. Mapping of the present status of erosion was done by the Land Use Planning Section in the Ministry of Agriculture in 1990 using the Southern African Regional Commission for Conservation and Utilization of the Soil (SARCCUS) method (Manyatsi and Maseko, 2010). The Actual Erosion and Land Degradation Assessment (AELDA) were set up for Swaziland by Jansen *et al.* (1994) following an earlier work by FAO. The AELDA produced basis for the production potential of the land which is essential for land use planning procedures. In assessing land degradation status in Swaziland, methods of assessment of the condition of rangelands were developed by Manyatsi (1997), using remotely sensed data. To identify the impact of factors controlling soil erosion, Manyatsi (1999a) conducted a Spatial Analysis of Soil Erosion (SASE) in Swaziland. A binary classification was applied to broad land cover classes map produced from image classification to separate the land cover classes into eroded lands and non-eroded lands in the country. The other forms of land degradation have not been extensively researched and there is no specific approach or methodology that has been used in Swaziland (Manyatsi and Maseko, 2010).

This study was conducted to determine the status of land degradation and its implications for

Velezizweni chiefdom situated in the rural area of Swaziland. Specific objectives were to assess the degree of soil erosion and the perception of community members on land degradation. The results of the research will provide baseline information for the planning and implementation of sustainable management practices at community level. It will also provide crucial information to guide the government on addressing the problems of land degradation.

METHODOLOGY

Description of study area: The study was conducted at Velezizweni chiefdom during the period of January to March 2011. The study area is located in the Highveld of Swaziland (Longitude: 26.683°S; Latitude 31.117°E), under the Manzini administrative region (Fig. 1). Its altitude ranges from 800 to 1400 m above sea level. The long term annual rainfall of the area ranges between 700 and 1200 mm/annum and the long term mean minimum and maximum temperatures are 10 and 26°C, respectively. The area is divided into nine communities, all of which are under the same chiefdom. The communities are Ngwempisana, Dladleni, Mhlatane, Deda, Mabovini, Lukhetseni, Mtimane, Ekukhulumeni and Enkhangala (Fig. 2). The

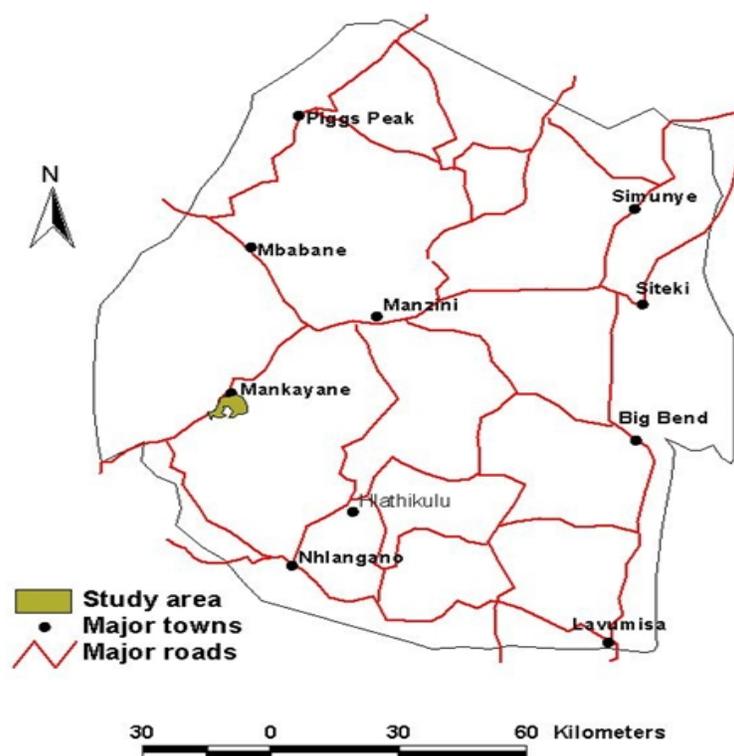


Fig. 1: Map of Swaziland showing major towns and study area (Velezizweni)

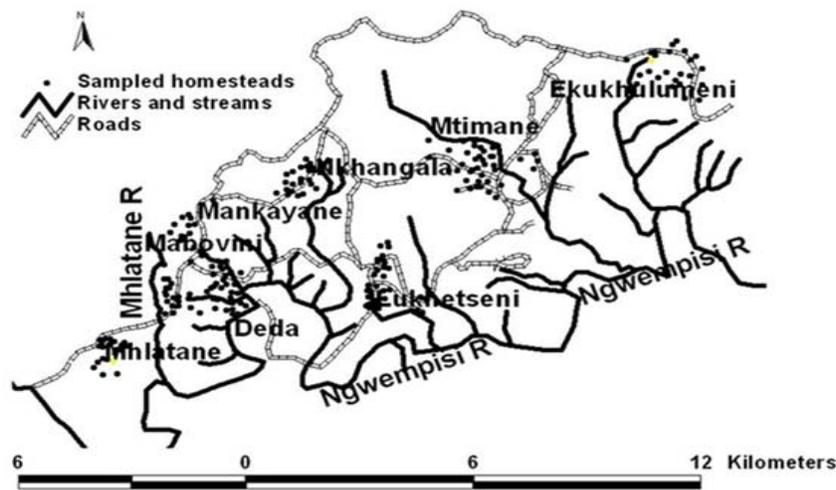


Fig. 2: Distribution of sampled homesteads within the different communities

study area focused on seven communities of the chiefdom and excluded Ngwempisana and Dladleni communities that were involved in chieftain disputes. The seven communities had a total of 360 homesteads. Mankayane, a small hamlet with a population of about 5600 people is situated at the north boundary of the chiefdom (Fig. 1). Services found within the hamlet include a secondary school, one primary school as well as the Ministry of Agriculture offices. Subsistence agriculture is dominant in the area with maize, sweet potatoes and beans being the main crops grown.

Land cover and soil erosion mapping: Landsat ETM digital data acquired in December 2009 was used to determine the level of soil erosion in the area. The digital data used were ETM 3 (Red band), ETM 4 (Near Infra-Red band) and ETM 5 (Middle Infra-Red band). Landsat ETM data has spatial resolution of 30 m, meaning that the smallest element that could be detected was 30×30 m. A color composite was created using the three bands. Five land cover features were visually identified on the composite image; plantations, shrubs/bush, eroded soils, moderate vegetation cover and poor land cover. Four polygons were digitized representing each of the land cover features using IDRISI 15 digital image software (Clark University, 2008). The polygons were used to develop “signatures” for the different land cover features. The “maximum likelihood” module of IDRISI 15 was used to undertake supervised image classification of the study area. The resulted classification image was exported to Arc View GIS (ESRI, 2003). The area under each of the five land cover features was determined.

Perception of land users: A questionnaire was developed to solicit information on the perception of land users/community members on land degradation in

the area. It included human capital, homestead composition, natural capital, land degradation, financial capital and production, vulnerability context and physical capital. A list of homesteads within the study area was obtained from the community headman and the homesteads were assigned identification numbers. The sample size calculator was used to determine the required sample size from a population of 360 homesteads for collection of data on the perceptions of land users/community members on land degradation (Creative Research Systems, 2010). The sample size needed was found to be 190 homesteads (at 95% confidence level and 5% confidence interval). The required number of homesteads was randomly selected from the list of all the homesteads. A questionnaire was administered to each of the selected homesteads, where an adult member was interviewed and the responses were recorded.

Data analysis: The information collected from use of questionnaire was coded and entered into the Statistical Package for the Social Sciences (SPSS) software for analysis (Statistical Package for the Social Sciences, 2008). Descriptive statistics were obtained and the results were presented in form of tables and charts.

RESULTS AND DISCUSSION

Land cover and soil erosion: The five land cover features that were determined from digital image classification were plantations, shrubs/bush, eroded soils, moderate vegetation cover and poor vegetation cover. About 19% of the study area was classified as eroded with another 44.9% classified as having poor vegetation cover. Plantations that composed mainly of pine trees covered 15.8% of the area. Shrubs and bush were dominantly found in grazing areas. The bush and

Table 1: Land cover classes of the study area

Land cover feature	Area covered (ha)	(%) of area covered
Forest plantations	786	15.8
Shrubs/bush	568	11.4
Moderate vegetation cover	421	8.50
Poor vegetation cover	2230	44.9
Eroded soils	958	19.4
Total	4963	100.0

Table 2: Dominant type of land degradation on cropping land as perceived by respondents

Community	Number of respondents				Total
	Soil erosion	Loss of soil fertility	Acidity	No response	
Mhlatane	12	7	1	0	20
Deda	16	10	1	5	32
Mabovini	6	13	0	8	27
Nkhangala	3	13	0	7	23
Lukhetseni	11	16	2	5	34
Mtimane	17	5	0	11	33
Ekukhulumeni	11	9	1	0	21
Total	76	73	5	34	190

shrubs were the main source of firewood for the area. On the other hand 8.5% of the area was classified as having moderate vegetation cover (Table 1).

Land degradation on cropping lands as perceived by respondents:

About 81% of the respondents perceived land degradation as a problem in cropping land. Seventy six out of the 190 respondents (40%) reported that soil erosion was the dominant land degradation problem, while 73 out of the 190 respondents (38%) reported that loss of soil fertility was the dominant land degradation problem (Table 2). The other type of land degradation reported was acidity, with 5 respondents (2.6%) reporting so. The study area is situated in the Highveld of Swaziland, an area with relative high rainfall. The slope is generally steep. The area is inundated with gullies, especially in grazing lands. The rainfall also washes away the topsoil in the fields, thus reducing the soil fertility, resulting in low productivity. The Ministry of Agriculture provides a service to the communities where soil pH is assessed on regular basis.

Farmers are given advice on liming requirements on the basis of the pH assessment.

Land degradation on grazing lands as perceived by respondents:

Grazing is done on communal basis at Velezizweni. The number of livestock kept by each family is not regulated and the carrying capacity of the rangelands is not known. This has led to overstocking and degradation of rangelands. In this aspect 171 respondents (90%) reported that land degradation was a problem in the grazing areas. Soil erosion was perceived to be a problem by 73 respondents (38.4%). On the other hand 48 respondents (25.3%) reported that reduced quality of grazing land was a problem (Table 3). The reduced biomass was a result of overgrazing and poor management of the grazing land. No one takes full responsibility of management of rangelands in communal grazing areas in the country. Loss of palatable species was perceived as a problem by 36 respondents (19%). Invasion of alien plant species is one of the serious problems in grazing lands in Swaziland. The worse environmental weed is *Chromoleana odorata* (Triffid weed) that has been declared a national disaster. Wattle trees (*Acacia pycnantha*) were introduced in the late 18th century for their timber and bark in the Highveld of Swaziland. However the wattle has gone out of control and invaded rangelands at Velezizweni and other areas of Swaziland.

Perceived causes of land degradation:

The causes of land degradation as perceived by the respondents on cropping land and grazing land are shown in Table 4 and 5, respectively. The majority of the respondents (68%) perceived high rainfall as the main cause of land degradation in cropping land. The long term average annual rainfall for Mankayane (the nearest weather station to Velezizweni) is 803 mm. It normally falls between the periods of September to March, with December, January and February being the wettest

Table 3: Dominant type of land degradation on grazing land as perceived by respondents

Community	Number of respondents					Total
	Soil erosion	Reduced biomass of grazing land	Reduced quality of grazing land	Loss of palatable species	No response	
Mhlatane	7	5	5	3	0	20
Deda	16	0	9	5	2	32
Mabovini	7	4	9	5	2	27
Nkhangala	8	0	0	2	13	23
Lukhetseni	13	2	8	9	2	34
Mtimane	18	2	8	5	0	33
Ekukhulumeni	4	1	9	7	0	21
Total	73	14	48	36	19	190

Table 4: Number of respondents perceiving factor as main cause of land on cropping lands

Community	Number of respondents							Total
	Too much rains	Poor land management	Poor drainage	Poor soil structure	Steep slopes	Poor crop rotations	No response	
Mhlatane	15	2	0	2	1	0	0	20
Deda	13	1	0	3	1	0	14	32
Mabovini	7	5	0	4	1	2	8	27
Nkhangala	15	1	0	0	1	0	6	23
Lukhetseni	12	1	3	3	0	1	14	34
Mtimane	11	0	0	4	0	0	18	33
Ekukhulumeni	12	1	1	2	0	0	5	21
Total	85	11	4	18	4	3	65	190

Table 5: Number of respondents perceiving factor as main cause of land degradation on grazing lands

Community	Number of respondents						Total
	Poor soil structure	High livestock numbers	Too much invasive trees	Overgrazing	Poor management	No response	
Mhlatane	0	7	1	4	5	3	20
Deda	0	4	4	10	0	14	32
Mabovini	1	7	0	7	4	8	27
Nkhangala	0	0	0	2	1	20	23
Lukhetseni	8	3	4	9	5	5	34
Mtimane	4	4	3	13	4	5	33
Ekukhulumeni	3	4	2	8	2	2	21
Total	16	29	14	53	21	57	190

Table 6: Dominant sustainable land management practiced by respondents

Community	Number of respondents					Total
	Apply kraal manure	Plough across slopes	Grass filter strips	Establish waterways	No response	
Mhlatane	3	5	2	6	4	20
Deda	8	3	0	0	21	32
Mabovini	11	3	0	1	12	27
Nkhangala	13	1	0	2	7	23
Lukhetseni	11	5	2	2	14	34
Mtimane	4	7	0	1	21	33
Ekukhulumeni	5	7	0	2	7	21
Total	55	31	4	14	86	190

months. When the first rains fall in September, the fields are often bare, without any cover, as maize stover and other crop residues are devoured by livestock during the dry season. This leads to serious soil erosion in the fields. The other perceived causes of land degradation include poor soil structure and poor land management with the number of respondents reporting them being 18 and 11 respectively (Table 4).

The majority of respondents attributed the causes of degradation in grazing land to factors related to livestock numbers, as 82 respondents (61.7%) perceived the causes as either overgrazing or high stocking rates (Table 5). Overgrazing is due to a number of factors that include the state of the rangeland (carrying capacity), the livestock numbers and rangeland management aspect. The total number of cattle and goats for the area (Velezizweni dip tank) was 1430 and 1560, respectively in December 2010. The boundaries for the grazing area are not well defined and thus it is not easy to determine the stocking rate. However, Manyatsi (1999b) estimated it to be about 2750 ha. The area was estimated to be overstocked by

55 Livestock Units (LSU). It is worth noting that over the past 12 years (1999-2011) the grazing area has been reduced at Velezizweni, like in many parts of the country, as land is taken for settlements and cropping purposes. Casual observations also show that the condition of the rangelands has deteriorated due to invasion of alien plant species among others. The carrying capacity is expected to have been reduced over the years, while the livestock population would have not changed significantly. This supports the observations of the respondents that overgrazing is the main cause of land degradation in rangelands.

Sustainable land management practices: Sustainable land management was practiced in cropping land and not in communally grazed land (Table 6). Fifty five respondents applied kraal manure to improve soil fertility and soil pH. In most cases the quantity of kraal manure added was not adequate to meet the nutrient requirement of the crops. The farmers had to add inorganic fertilizers over and above the addition of kraal manure. Thirty one respondents reported to

cultivate across the slope and another four reported to be having grass filter strips in their fields. Observations however showed that more or less all the cultivation was done across the slope at Velezizweni and farmers had grass filter strips in their fields. The farmers observed the dictates of the Kings Order of 1953 which stated that no person was to plough up and down the slope of a hill, but were to always plough across the slope. It also demanded that grass filter strips were to be left between ploughed lands at such intervals as advised by agricultural extension officers (Nsibandze, 1987). The grass strips are usually 2 m wide at intervals of between 5 and 20 m depending on the slope of the land, being closer on steep slopes. Ploughing across the slope and grass filter strips are integral part of arable agriculture in Swaziland, including Velezizweni and one would have expected the majority, if not all the respondents to respond that they practiced them. Waterways were established by 14 respondents.

CONCLUSION AND RECOMMENDATIONS

The results showed that land degradation was more severe in communal grazed land as opposed to cultivated land. The degradation came in the form of soil erosion and invasion of alien plant species. The communal grazed land was overgrazed, as there were no structures or policies to oversee the control of livestock numbers and to manage the grazing land. On the other hand individual farmers practiced sustainable land management in their cropping fields. The practiced included cultivating along the slope and having grass strips in their fields. There is need to demarcate the communal grazing land and fence it properly. This would make it possible to calculate the appropriate carrying capacity of the grazing area, hence proper management. Farmers should make financial contribution to purchase fencing material so that they can have ownership of the initiative. As a result of ownership good management of these areas could be attained. The community should take a leading role in controlling erosion and the invasion of alien species in their grazing areas, with assistance from the Ministry of Agriculture. Areas that were highly eroded in the form of gullies should be fenced off and trees planted to reclaim the land. The Ministry of Agriculture should provide extension service to give advice on livestock management practices and crop husbandry. This would play a major role in reducing land degradation.

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