Landscape change in arid and semi-arid rangeland of Borana, southern Ethiopia: implication for management

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Introduction

The Borana rangelands in southern Ethiopia (between 4°3'N to 5°0'N and 37°4'E to 38°2'E) comprise important cultural landscapes with a unique feature of the *tula*-well landscapes. Until a few decades ago, the Borana rangelands were considered one of the most productive and resilient ecosystems in East Africa. In recent years, however, the Borana rangelands have undergone a large reduction in grassland cover probably as a result of anthropogenic and natural-induced factors (Coppock 1994), with consequences on the livelihood of the local communities. Therefore, the objective of the study was to investigate the dynamics of landscape change in the Borana rangelands of Ethiopia based on satellites imagery.

Materials and methods

The study was conducted in Borana rangelands of southern Ethiopia, Yabello district. The Borana rangelands cover a total area of approximately 95,000 square km (Coppock, 1994). The northern part of the Borana rangeland is bordered by the neighboring highlands. The southeastern is bordered by Somalia, while the southern limit is bordered by Kenya.

Three satellites images (TM 1987, TM 1995 and ETM+ 2003) were analysed. Prior to analysis geometric correction were made. Images were classified at pixel level using supervised maximum likelihood classifier. The spatial pattern of the study area was determined using selected matrices by the FRAGSTAT software 3.3 public domain software (McGarigal *et al*. 2002). Furthermore, to understand the dynamics of LULC (land use and land cover change), the possible major drivers and consequences of the changes were explored using group discussion with local elders and key informants.

Results

Table 1 presents the magnitude of LULC (land use and land cover change) changes between 1987 and 2003. Shrub grassland showed the greatest reduction during the period, while settlement increased.

Table 2 presents the changes in spatial matrices at the landscape level in the Borana rangelands between 1987 and

Table 1. Area coverage and rate of LULC change from 1987 and 2003 in Borana rangelands, southern Ethiopia.

LULC	1987 (km^2)	1995 (km^2)	2003 (km^2)	% change from 1987 and 2003
Woodland	1209.5	1478.9	1369.5	11.7
Bushland	1197.1	1161.2	1444.0	17.5
Grassland	2172.1	1925.2	1994.4	-7.7
Shrub grassland	713.1	705.3	379.0	-86.1
Bare land	110.1	109.1	108.2	-0.7
Cultivation	16.6	28.1	59.3	72.5
Settlement	7.9	18.7	72.0	79.8
Total	5426	5426	5426	

Table 2. The calculated landscape matrices at the landscape level in Borana rangelands, southern Ethiopia.

Parameters	1987 (km^2)	1995 (km^2)	2003 (km^2)	% change from 1987 and 2003
Number of patches - NP	265102	307226	316725	19.5
Patch density – PD (no/100 ha)	28.9	33.5	34.6	19.5
Largest patch index – LPI (%)	40.0	35.5	21.8	-45.8
Patch richness - PR	7	7	7	0
Shannon's diversity index – SHDI	1.5	1.53	1.53	1.3
Shannon's evenness index – SHEI	0.7	0.74	0.74	1.4
Landscape shape index – LSI (m)	196.1	238.4	246.1	25.5
Mean patch fractual dimension – FRAC_MN	1.03	1.04	1.03	0
Mean shape index – SHEP_MN	1.2	1.18	1.2	0
Mean nearest neighbour distance (m)	9.35	87.5	91.8	-1.8

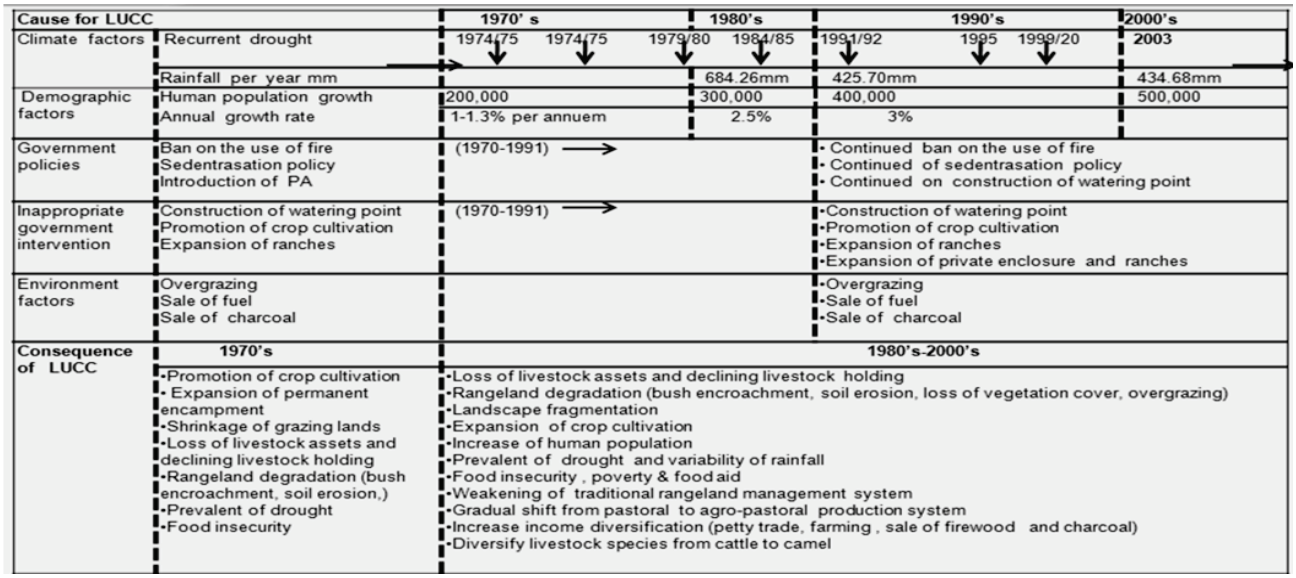

Figure 1. The underlying cause for LULC change and consequence in Borana rangelands, southern Ethiopia.

2003. The LPI (largest patch index) decreased, while the LSI (landscape shape index) increased.

The main events responsible for LULC change and associated consequences are presented in Figure 1.

Discussion

The study highlights grassland and shrubby-grassland covers declined over the study period. As the livelihood of Borana pastoralists have been heavily dependent on cattle production with grasslands as the main source of feed for cattle, the progressive decline in grassland cover can directly impact cattle production. Such a trend most likely contributes to reduced resilience and high vulnerability of the local people to food insecurity. Generally, the size of woodlands, bush-land, settlement and cultivated land covers have rapidly increased.

Landscape fragmentation is one of the emerging issues as a result of LULC change in the Borana rangelands of southern Ethiopia. This indicates that the original grassland state was fragmented into a large number of small patches through increased patch density, decreasing the largest patch index and irregular shape of patch within a landscape.

Conclusions

Our results suggest that the underlying causes of LULC changes are mostly attributed to the impact of climatic related factors (*e.g.* rainfall variability and recurrent drought), demographic (population growth), inappropriate government policies and other environmental factors (over grazing, sale of fuel wood and charcoal). Changes in LULC greatly contribute to the loss of livestock asset, rangeland degradation due to landscape fragmentation and weakening of traditional institution in rangeland management. The fragmentation of a vast area of grasslands into smaller patchy landscapes may support the claim that the Borana rangeland has been degraded.

References

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