Consilience: The Journal of Sustainable Development
Vol. 15, Iss. 1 (2016), Pp. 192-218

Indigenous Ecological Knowledge and Pastoralist Perception on Rangeland Management and Degradation in Guji Zone of South Ethiopia

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Abstract

The study was conducted to explore range management practices, and pastoralists' views on degradation and its impact on local livelihood in south Ethiopia. The data was gathered from three pastoral and agro-pastoral districts of the Guji zone using structure questionnaires, key respondents and direct observation. The study shows the use of enclosure and herd mobility in basic traditional practice as well as the effectiveness of community indigenous knowledge in assessing and monitoring rangeland degradation. Communities used numerous indicators to explain local level degradation, finding drought to be a primary cause of the decline in household livestock assets, the expansion of aridity, and as a rising threat to food security. The study shows an alarming increase in degradation and the urgency of measures to halt this trend.

Keywords: Indigenous knowledge, rangeland degradation, Guji pastoralists, Ethiopia

1. Introduction

Pastoralists have managed their production system for many centuries, accumulating detailed knowledge of the environment of their grazing landscape (Oba and Kotile, 2001; Mapinduzi et al., 2003). Turner et al., (2000) suggested that traditional knowledge of the indigenous people was fundamentally important in the management of local resources. Other studies (e.g. Fernandez-Gimenez, 2000; Angassa and Oba, 2008) documenting local ecological knowledge of rangeland resources have provided useful information for the development, sustainable utilization and conservation of natural resources. Additionally, local ecological knowledge may provide new insights into improving existing scientific research, in addition to a basis for designing appropriate research and development policies.

Despite the availability of this valuable resource, researchers and development experts have previously overlooked indigenous knowledge in the evaluation of rangeland (Abate et al., 2009). In arid and semi-arid African rangelands, pastoralists are blamed for contributing to range degradation, but rarely considered a critical authority on the rangeland (O'Leary, 1984). Many studies (Roba and Oba, 2008; Dabasso et al., 2012) have suggested that integrating the knowledge of local communities would improve the current understanding of the mechanisms involved in range degradation. Other studies (Angassa and Oba, 2008; Roba and Oba, 2009a) have indicated that a combination of pastoral indigenous knowledge and modern scientific information would help provide a better understanding of the environment from the perspective of resource utilization. Generally, in arid and semi-arid rangeland of Ethiopia and particularly in Guji pastoral and agro-pastoral system, the indigenous ecological knowledge, views on the current rangeland conditions, and degradation and management strategies of pastoralists have not been documented. This study aims to explore whether local communities are able to use environmental indicators to describe local range degradation and its impact on environment and local livelihood. It focuses on the following three areas: (i) traditional grazing land management practice (ii), perception of local communities on range degradation, underlying cause and their impact (iii), assess the role of pastoralists' indigenous ecological knowledge, challenge and system stability in southern Ethiopia.

2. Materials and methods

2.1. Description of the study area

The study was conducted in three neighboring pastoral and agro-pastoral districts of the Guji Zone in Oromia Regional State of south Ethiopia. The Guji zone borders on the North with the Gedeo zone and the Sidama zone, on the South with the Somali Regional state, on the East with the Bale zone, and on the West with Borana zone. The total land area of the zone is 18,577 square kilometers. The Gugi zone is estimated to have a human population of 1,590,225 (CSA, 2005) and lies within the altitude range of 700-3500 meters above sea level (m.a.s.l). The zone has 13 districts, out of these five were categorized as pastoral and agro-pastoral districts. This study was conducted in three of these neighboring districts: Wadera, Gorodola and Liben.

The climate of the pastoral and agro-pastoral regions of the Guji zone is mostly arid and semi-arid. The inter-annual rainfall was varied with an average annual rainfall of 526.75 mm. The rainfall pattern is bimodal the major season (*Ganna*) which extend from March to May and received 60% of the annual rainfall, the minor season (*Hagayya*), which extend from September and November received 40% of the annual rainfall. The mean annual temperature range is 24–30^{0}C (Adi et al., 2003). Drought is common in the study area every five to ten years.

The Guji Oromo are the dominant ethnic group in the study area and Borena, Arsi, and Somaile are ethnic groups living in peaceful coexistence. In the Liban district, Borena Oromo are numerically the dominant ethnic group. The livelihoods of the community are predominantly dependent on livestock production and in some area's agriculture. They are predominantly pastoralists, agro pastoralists, and farmers. The Guji and Borana communities have a well-established indigenous system in the management of grazing lands and other natural resources as well as an organized social institution: the 'Gada'[1] system.

2.2. Methodological approach

Data was gathered using a multiple visit formal survey method (ILCA, 1990). Prior to the actual survey, visits were made to the districts to gather secondary information from all possible sources. Group discussions were held with key informants, development agents and district agricultural officers. A structured questionnaire was designed to obtain data on household demography

[1] The word "*gada*" is a system of social organization among the Oromo society used to be regulated by the *gada* principles. In the Borana region of southern Ethiopia *gada* is a system of classes (*luba*) that succeed each other every 8 years in assuming military, economic, political and ritual responsibilities (Legesse, 1973). Each *gada* class remains in power during a specific term (*gada*), which begins and ends with a formal ceremony. The concept *gada* has three related meanings: It is a period of eight years during which elected officials take power from the previous ones; It is the grade during which a class of people are in power by having politic-ritual leadership; It is the institution of the Oromo society.

characteristics, livestock holding, household income, rangeland management practice, mobility, current rangeland conditions, range degradation, local indicators, bush encroachment, and role of indigenous knowledge. The questionnaire included both closed (single response) and open (multiple responses) questions. A pre-test of the questionnaire was made before the actual data collection in order to later make appropriate modifications and corrections. In each district, representative Pastoral Associations (PAs) were selected based on accessibility, representativeness of grazing land, and livestock potential. A total of 211 household (HH) consisting of 91 households from Wadera district, 60 households from Gorodola, and 60 households from Liban district were randomly selected and interviewed.

2.3. Statistical analysis

The collected household data was analysed using Statistical Package for the Social Sciences (SPSS, Version 19, 1996). Descriptive statistics were used to present the results.

3. Results

3.1. Household demographic characteristics

A Guji/Borena household consists of a man, his wife, their children and any others dependent on them for food. These additional members may include kin or non-kin members (Hogg, 1992). The survey showed that the average household size of a family within the study areas is 10.4±7.0 (± SD) people (Table 1). Of the total respondents, 10.4% were female-headed households and the remaining were male—because males are often heads of the family and strong cultural practice prevented females from responding on its behalf. Among the total respondents, 71.6% were of the Guji ethnic group, followed by the Borena (16.1%), while the remaining consisted of Arsi, Somali, and others. The mean age of respondents was 45.2±11.4 years with the age range of 26-88 years. Among respondents 46.4% had no formal education with only 5.7% of respondents educated past the 8th grade.

3.2. Evolution of agro-pastoralism

Forty years ago, livestock production was practiced by most respondents and all inhabitants were pastoralists. Livestock and livestock products played a major role and the rangelands were used mainly for grazing. Currently, most respondents (99.5%) practiced an agro-pastoral lifestyle, combining livestock and crop production. Crop cultivation was reported to be higher in the Wadera district than in the Gorodola and Liban districts. Maize, haricot bean, wheat, teff, and barley were the major crops grown in the study area.

Table 1. Household demographic characteristics in Guji zone of South Ethiopia, (n=211)

Parameters	Wadera	Gorodola	Liban	Mean
Age of respondent (years)	41.4±10	44.8±10	51.4±12	45.2±11
Male headed household (%)	83.5	96.7	91.7	89.6
Female headed household (%)	16.5	3.3	8.3	10.4
Ethnic group (%)				
Guji	100	85.0	15.0	71.6
Borena			56.7	16.1
Arsi			26.7	7.6
Somali			1.7	0.5
Others		15.0		4.3
Age categories mean ± SD (number)				
≤15	6.6±4.3	6.4±0.5	5.9±3.3	6.3±3.9
Age16-64	2.9±2.6	2.9±0.4	3.6±2.0	3.1±2.6
Age≥65	0.8±0.8		1.0±0.3	1.0±0.5
Total family size	10.3± 7.7	9.3±0.9	10.5±5.6	10.4±7.0
Level of education (%)				
Cannot read and write	37.4	50.0	56.7	46.4
Read and write	19.8	25.0	6.7	17.5
Basic education	16.5	11.7	30.0	19.0
Primary education (5-8)	17.6	6.7	6.7	11.4
Secondary education (9-10)	8.8	6.7		5.7

Most of respondents (48.3%) started growing crops after 1991, the year of the socialist military Derg regime's downfall, although about 44.5% respondents were already doing so during the Derg regime (Table 2). The reasons for adopting an agro-pastoral lifestyle included: the need to diversify household income (29.1%), human population growth (19.6%), expansion of settlements and promotion of crop cultivation (19.0%), owing to drought (17.0%), and a decline in livestock numbers per household (15.0%). The Derg regime implemented a settlement program in 1970's. Settlement in villages had brought social change among the Guji-borena pastoralists: First, it influenced the people to adopt agro-pastoralism in favor of pastoralism, as well as a move from mobile and scattered residence to settled and confined villages. These changes were accompanied by new ways of life in which crop cultivation, formal education and division of labor at a household level were introduced. Additionally, inappropriate development interventions during the Derg regime (e.g. the construction of watering points in traditional rainy-season pastures, a ban on the use of fire, and the introduction of a peasant association), the weakening of local institutions, and repeated drought and massive loss of livestock exhausted the resources of many families. Furthermore, there have been several government initiatives to provide extension services to promote crop cultivation into the most valuable grazing areas. Currently, among respondents, 54% considered crop cultivation encouraging. However, 42.7% of respondents indicated discouragement and the remaining 3.3% of respondents failed to make suggestions (Table 2).

3.3. Traditional grazing land management practice

The traditional grazing land management practiced is presented in Table 3 and 4. The majority of respondents (92.9%) had access to local enclosures called *kaloo*. Forms of enclosure included the *kaloo jabi* (used mostly for calves), which are privately-owned, small, and relatively near the homestead. Most respondents (46.4%) owned enclosures privately, 36.1% were owned communal, and the remaining 22.2% of respondents had both types of enclosures.

Table 2. Major farming activities, time and reason for emergency of agro-pastoralism in Guji zone of South Ethiopia (n=211)

Parameters	Wadera	Gorodola	Liban	Mean
Have you started faming activities (%)				
Yes	100	98.3	100	99.5
No		1.7		0.5
Time of expansion (%)				
During Haile sellassie regime*	5.5	8.3	8.3	7.1
During Derg regime **	48.5	55.1	28.3	44.5
After the down fall of Derg regime***	46.2	36.7	63.3	48.3
Reason for cultivation (%)				
Income diversification	34.2	27.2	22.6	29.1
Human population pressure	21.8	18.4	18.5	19.6
Expansion of settlement and promotion of crop cultivation	19.3	20.9	16.4	19.0
Drought	13.2	15.8	24.7	17.0
Death of livestock population and disease	11.5	17.7	17.8	15.0
Perception of community toward cultivation (%)				
Encouraging	49.5	43.3	71.7	54
Discoursing	46.2	51.7	28.3	42.7
I don't know	4.4	5.0		3.3

***, Before 1974 GC **Between 1974 to 1991, *After 1991

Communal enclosures were accessible to all members of the community and open to communities when feed resources were depleted in communal grazing areas during the long dry season. Communal enclosures were controlled by *Abboti Dedha* (the elderly who were elected to mange grazing land) and these grazing lands were often unfenced. The private enclosures were owned by individual families and controlled to ensure conservation of forage for the animals. Enclosures were usually located around the homestead and farmlands, mainly used for feeding of lactating cows, calves, and weak or sick animals during the dry season. Among the total respondents, 52.6% responded that they owned enclosures for dry season use and drought mitigation strategies,

6.2% for rehabilitation strategies, while the remaining 40.2% responded that enclosures were used for both purposes. Most informants (88.7%) used different management strategies to improve their enclosures, including: fencing (56.6%), bush cleaning (36.0%) and burning (11.0%). Despite efforts for improvement, bush encroachment (33.7%), shifts to cropland (21.2%), recurrent drought (20.6%), inadequate fencing (12.7%) and termite infestation (11.8%) posed as the main consequences of changes to enclosure (Table 4).

Communities categorized the grazing landscapes into two main landscapes, such as the *Badaa* and the *Gamojii,* using a combination of climate (rainfall and temperature), soil, topography, and vegetation. The *Badaa* landscapes were characterized by high amounts of rainfall, cool temperatures, highlands, and dense vegetation cover. These were used for dry season grazing and are found mainly in the Wadera and Gorodola districts. The *Gamoji* landscapes had low rainfall, warm temperatures, lowlands, and sparser vegetation. These are mainly used for wet season grazing and can be found commonly at the three the study districts. Furthermore, in the Liban district, the grazing lands were also partitioned into wet and dry season grazing areas. The wet season lacked permanent water supplies, which can only be utilized when rainwater, surface water and traditional pond water are available. When water sources were exhausted, the grazing then returned to the dry season rangelands. Generally, wet season areas were used for only a short period (mostly 2–3 months). In the Liban district, the *Didi Liban* grazing land, a dry season grazing land which acted as a key resource of rich perennial grasslands, water sources and *hayya* soil crucial for livestock production and grazing land management.

Table 3. Traditional rangeland utilization and management practices in Guji zone of South Ethiopia (n=211)

Management practice	Wadera %	Gorodola %	Liban %	Mean %
Use of enclosure	97.8	96.7	81.7	92.9
Division of herd	69.2	55.0	93.3	72.0
Moving animal during dry season	74.7	83.3	98.3	83.9
Migration with olla for period of time	49.5	100%	86.7	74.4
Moving animal to relative and clan member	59.3	75.0	56.7	63
Burning	25.3	25.0	25	25.3

Diversifying herd composition and division of herds based on the species and class of animal was found to be common practice. 72% percent of respondents split their herd into *warra* herds (village-based) and *fora* herds (satellite herds). In village-based herds, calves and small ruminants were kept around the homestead, as were animals under production (lactating cows), sick animals, and calves during the dry season. *Fora* herds (bulls, heifers, dry cows and camels) utilized pasture and water remote from the homestead during wet season**.** Of the respondents, 83.9% moved animals during dry season to water points and use forage resources that are found at the daily walking distances locally called *Meta Tika.* Migration with *olla* for period of time (19.2%), moved animal to relative and clan member (63%) to exploit areas remote from permanent settlement sites and use of fire (25.3%) in traditional grazing land

practice (Table 3). Most respondents (74.4%) used seasonal herd mobility and moved livestock seasonally to exploit areas remote from permanent settlement sites. The extent and direction of movements depend on the availability of rainfall, water, feed, and security. In the dry season livestock, cows, bulls, heifers, goats, sheep, and camels were moved to remote sites where water and feed were abundant. Household heads and boys above the age of 15 years were responsible for the migration of the animals.

The majority of respondents (49.8%) indicated that the frequency of migration decreased over time, owing to settlement, declines in livestock ownership per household, human population, and government policy (e.g. the encouragement of settlement, education, crop farm and water points). The remaining 27.5% indicated that the intensity of migration has increased because of shortage of rainfall (i.e., drought condition), feed and water. Respondents indicated feed shortage (49.8%), water shortage (49.3%), animal disease (44.5%), human disease (27.5%), wild animal attack (18%) and conflict (0.5%) posed as the main threats to migration. Most respondents indicated the role of mobility as survival (58.8%) and risk management strategies (45.5%), while 19.9% of respondents suggested that mobility has culture value, and 1% of respondents considered it as bad practice.

Table 4. Status of range enclosure in Guji zone of South Ethiopia (n=211)

Variables	Wadera	Gorodola	Liban	Mean
Do you have enclosure (%)				
Yes	85	96.7	85	91.9
No	6	3.3	15	8.1
Enclosure type (%)				
Communal	30.6	31.0	45.1	36.1
Private	51.8	41.4	43.1	46.4
Both	17.6	27.6	21.6	22.2
Do you use management to improve enclosure (%)				
Yes	82.3	98.3	88.2	88.7
No	17.6	1.7	15.7	12.9
Type of management used (%)				
Fencing	57.1	51.0	55.6	56.6
Bush clearing	29.4	38.0	39.7	36.0
Burning	13.4	11.0	4.6	11.0
Role of enclosure (%)				
Dry season and drought mitigation	57.6	53.4	45.1	52.6
Rehabilitation	4.7	13.8	1.9	6.2
Both	37.6	32.8	52.9	40.2
Challenge related to enclosure (%)				
Bush encroachment	35.2	34.0	30.4	33.7
Shift to cropland	23.6	13.5	28.4	21.2
Recurrent drought	19.1	19.2	25.5	20.6
Lack of fencing	12.1	20.5	2.0	12.7
Termite infestation	10.1	12.8	13.7	11.8

3.4. Livestock production system and household income

Livestock have been the main asset of local communities, with an average livestock holding per household of 12.7 Tropical Livestock Units (TLU = 250 kg non-lactating animal; ILCA, 1991) (Table 5), of which 8 TLUs were cattle. Pastoralists in the Liben district have the highest total livestock and camel population followed by those in the Gorodola and Wadera districts. Most households indicated that livestock management was traditional with a free-grazing, extensive system. 95% percent of respondents derived income from livestock, sale of small ruminants and dairy products, sale of crops (77%), off farm (40%), petty trade (33.2%), sale of forest products (36.5%), employment (1.9%), sale of honey (61.6%), remittance (6.2%), food aid (9%) and causal labor (5.2%) to cover expenses. According to respondents, shortage of feed (68.2%) was the primary challenge to livestock production followed by drought (59.7%), health problems (60.3%), scarcity of water (60.2%), market problem (41.7%) and wild animal attack (33.2%).

Table 5. Mean livestock holdings (TLU[1] ±SD) per household in Guji zone of south Ethiopia (n=211)

Livestock class	Wadera	Gorodola	Liban	Mean
Cattle	7.2±3.9	8±045	9.08± 6.13	8.0 ± 4.6
Sheep	0.01±.03	0.09±0.03	0.4± 0	0.06 ± 0.18
Goats	1.0±.0.04	1.71± 1.3	1.8 ± 0.93	1.43 ± 0.95
Camels	0.57±1.9	2.32±0.33	3.5 ± 3	1.88 ± 2.77
Equines	1.1±0.58	0.80±0.04	0.98 ± 0.58	0.96± 0.52
Total	9.9±5.3	13.02±0.77	15.23 ± 8.92	12.3 ± 7.03

3.5. Feed resources

Natural pastures, woody plants and crop residues were the major feed resources for livestock in the study area. Despite low availability of crop residues, straw from maize, sorghum, and teff were used during the dry season. As most of the lands were covered with woody vegetation, trees and shrubs were sources of livestock feed. Grazing was the main form of feed utilization, and grazing lands were communal and grazed continuously throughout the year. Natural pasture was available to animals mainly from March to May (main rainy season) and September to November (short rainy season). During the dry season, natural pasture, browse plants and standing hays were important. Most respondents (97.8%) in Wadera, (100%) in Gorodola and (98.6%) in Liben district has a critical feed shortage both in the short and in the long dry season.

Table 6. Status, challenges, land tenure and perception of respondents to communal grazing land in Guji zone of south Ethiopia (n=211)

Variables	Wadera	Gorodola	Liban	Mean

Status of communal grazing land (%)				
Increasing	2.2	1.7	3.3	2.4
Decreasing	97.8	98.3	96.7	97.6
Opinion for decreasing (%)				
Shift to cropland	39.6	38.3	43.5	40.0
Expansion of village	31.2	31.6	39.8	33.4
Bush encroachment	29.2	30.1	16.7	26.4
Preference of land tenure system (%)				
Communal	28.6	58.3	65.0	45.0
Private	42.9	11.7	25.7	28.0
Both	28.6	30.0	13.3	26.5
Reason for preference of communal grazing land tenure (%)				
If the land is privately owned, the size will be decline	22.4	34.0	33.0	31.3
If the land is privately owned, restrict mobility and grazing	18.4	26.8	31.1	26.9
If the land is communally owned, strengthens relations among people	22.4	27.8	25.2	25.7
Our culture to use the land communally	16.7	11.3	10.7	16.1
Opinion to improve communal grazing land (%)				
Bush clearing	32.1	28.1	35.5	31.4
Make enclosure	25.9	35.3	36.6	31.9
Destocking	13.2	12.4	9.7	11.8
Burring	15.1	16.3	8.6)	14.2
Minimizing cultivation	13.7	7.8	9.7	10.9

The primary measure taken by communities to solve feed shortage was the use of enclosure (88.1%) followed by the use of browse trees (57.3%), migration (52.6%), and destocking (15.2%). Communities rarely sell livestock as the main measure to alleviate feed shortages. The majority of households (97.6%) considered the current status of communal grazing land was decreased as compared with the past forty years ago (Table 6). The main attributes of shrinking grazing lands included: shifts to cropland (40.0%), expansion of villages (33.4%) and bush encroachment (26.4%). The study assessed the community views on the type of land tenure they would prefer for future management of grazing lands. The majority of respondents (45.5%) would prefer a communal type of tenure, 28% preferred private, while 26.5% prefer both types. Preference towards a communal type of land tenure incorporated several different reasons—31.3% of households suggested that privately-owned land would reduce the size of land and 26.9% of respondents indicated that herd mobility and grazing would be restricted. About 25.7% of respondents reported that communal land would strengthen social relations among communities, while 16.1% of respondents reported that it was their culture to own communal land. The households indicated that enclosures (31.6%) and cleaning of bush (31.9%) were among the main strategies used to improve grazing lands (Table 6).

3.6. Natural minerals supplementation

Mineral supplement to livestock is an integral component of herd and grazing land management strategies of pastoralists. There were various types of natural minerals utilized by animals. Locally they are called '*Haya*', '*Hora*', and '*Bojjii*'. Communities identified *haya* as grey, black and red colour soil from which the minerals are derived. *Haya* is the most frequently used natural mineral as it can be found in dry and wet muddy form and is suitable for all kinds of animals. The majority of respondents (97.2%) supplement all classes of livestock, especially cattle in wet season, by leading them to the sources (47.9%), while 21.1% of respondents transport the mineral soil to homes to feed animals and the remaining 25.6% of respondents use both methods. *Hora* is found in the diluted form and is consumed by drinking. *Bojjii*' has a dull whitish colour, fine salt grains and is mainly used by camel. The mineral supplement was considered to induce rapid weight gain in livestock, increase milk yield, and stimulate cows for reproduction, as well as having medicinal value.

3.7. Local indictors, causes and impacts of rangeland degradation

Communities in the study areas are aware of the extent of degradation and the local indicators that have been used are depicted in Table 7. Communities used numerous indicators to describe degradation, encompassing: soil, vegetation, livestock, water, and termite infestation. Guji communities describe overgrazed lands as *Barbadaa,* which means few or no grass cover, as well as short in height. Degraded areas described as *Kuunchaaye* meant that even if there was enough rainfall in the area, these degraded lands did not produce any grass and had a high number of cattle trails and bare ground patchs. Local communities often assessed the current condition of rangelands, either individually or on a local group basis known as *Aburu,* using the following criteria: the availability of grass and water, the prevalence of animal and human disease, the suitability to different livestock species, and security for the herder.

There were different opinions on the current conditions of the rangeland as compared with forty years ago. 95% of respondents rated the current range condition as poor and degraded (Table 11). Respondents indicated recurrent drought (45.5%), human population (23.3%), farmland expansion (26.5%), overgrazing (12.8%) and bush encroachment (34.1%) as the main forms of degradation (Table 8).

The impact of degradation is presented in Table 9. Respondents named soil degradation (94.8%), decline in household livestock holding and output (93.4%), expansion of aridity (85.8%), deforestation (82.9%), food insecurity and poverty (85.8%), the need for alternative livelihood income and diversification (88.1%) (e.g., promotion of cultivation, petty trade, sale of charcoal and fire wood), herd diversification (80.1%) (e.g. shifts to camel and goat herding), and increased migration (67.8%) to urban centers for labor, mineral mining area and herd mobility as the impacts (Table 9).

Table 7. Indictors used to describe rangeland degradation in Guji zone of south Ethiopia (n=211)

Variables (%)	Wadera	Gorodola	Liban	Mean
Soil erosion, and high levels of dust in the air	98.9	81.8	95.0	89.6
Bare ground cover, presence of rills and gullies	97.7	83.6	95.0	89.6
Decline of forage biomass (Stubble height)	78.4	98.2	95.0	85.3
Decline of vegetation cover	89.8	88.9	88.5	85.3
Decline of desirable grass species	96.6	78.4	85	83.4
Increase of undesirable grass	94.3	93.9	83.3	84.8
Increase of undesirable tree and bush	94.3	93.9	83.3	84.8
Decline of livestock performance (rumen-fill, milk production, weight gain)	79.5	80.0	88.5	85.8
Decline water availability(Surface water and water flow diminish)	70.5	91.5	83.3	77.3
Termite infestation	64.8	65.2	56.7	57.3

Table 8. Possible cause of rangeland degradation in Guji zone of south Ethiopia (n=211)

Causes	Wadera %	Gorodola %	Liban %	Mean %
Recurrent drought	47.3[1]	36.7[1]	35.0[3]	40.8[1]
Shift to crop land	23.1[2]	56.7[3]	41.7[1]	37.9[3]
Overgrazing	26.4[4]	46.7[6]	36.7[5]	12.8[4]
Settlement	23.0[6]	30.0[4]	46.7[2]	12.8[6]
Population pressure	25.3[3]	48.3[2]	53.3[4]	22.3[2]
Bush encroachment	38.5[5]	56.7[5]	41.7[6]	34.1[5]
Lack of burning	23.1[7]	36.7[7]	45.0[8]	19.0[8]
Poor soil status	3.3[8]	16.7[8]	46.7[7]	17.1[7]
Limited knowledge of rangeland management	14.3[9]	68.3[9]	43.3[9]	37.9[9]
Reduced livestock mobility	6.6[10]	13.3[10]	10[10]	9.5[10]

Number in bracket shows ranking order

Table 9. Possible impact of rangeland degradation in Guji zone of south Ethiopia (n=211)

Impact of land degradation	Wadera %	Gorodola %	Liban %	Mean %
Poor livestock output and holding	88	81.7	100.0	93.4
Soil deterioration	88	91.7	95.0	94.8
Decline of biodiversity	82	80.0	81.7	84.8
Deforestation	87.9	100.0	75.0	82.9
Increase income diversification (Petty trade, sale of charcoal an fire wood	96.7	81.7	83.3	88.6
Introduce and use of camel	82.0	80.0	76.7	80.
Food insecurity, food aid and poverty	96.7	91.7	71.7	88.2

Increase migration	73.6	66.7	58.3	67.3
Change to more aridity	90.1	83.3	81.7	85.8
Decline milk production per animal	97.8	96.7	100.0	98.1

3.8. Herder perception on bush encroachment

The majority of respondents (93.8%) suggested that, compared with forty years ago, grazing lands are now covered with bushes and shrubs. Factors that triggered such bush encroachment, according to the respondents, include: uncontrolled livestock movement (55.0%), overgrazing (52.6%), drought (50.7%), and lack of the use of fire (40.3%). Nevertheless, 4.78% of respondents failed to make suggestions. The abundance of trees and shrubs in the rangelands were considered to engender a decrease in the production of grass (43.5%), difficulty in herding (34.6%), increased animal wounds (21.4%), and increased wildlife attacks (0.5%). The *Boyyoo* and A*caia* species in the Gorodoloa and *Acacia bussei, Acacia drepanolobium* and *Commiphora* species were the main encroaching species in the rangelands of Liban district. Additionally, most respondents, 93.4% in Wadera, 88.3% in Gorodola and 80.7% in Liben districts, reported that the invasion of poisonous plants in the rangelands is now higher compared to the forty years ago. Most of respondents (57.3%) indicated bush cleaning (42.4%) and burning (42.4%) as the main effort to control bush encroachment (Table 10)

Table 10. Reasons, consequence and management of bushes and shrubs in Guji zone of south Ethiopia (n=211)

Parameters	Wadera	Gorodola	Liban	Mean
Do you observe an increase in bush/shrubs (%)				
Yes	94.5	96.7	90.0	93.8
No	5.5	3.3	10.0	6.2
Opinion for cause (%)				
Uncontrolled livestock movement	53.8	65.0	46.7	55.0
Overgrazing	69.2	41.7	33.3	51.2
Drought	67.0	40.0	33.3	59.8
Lack of burn	39.6	40.0	36.7	38.9
I do not know	1.1			4.7
Consequence of bush encroachment (%)				
Shortage of grass	41.7	42.1	49.0	43.5
Create difficulty to herd	34.3	34.2	35.7	34.6
Wounding of animal	23.0	23.7	15.3	21.4
Predator	1.0			0.5
Bush control method (%)				
Clear	60.7	51.1	58.4	57.3
Burn	38.6	48.9	41.6	42.4
I do not know	0.7			0.3

3.9. Role of traditional knowledge, system stability and sustainability

The majority of respondents suggested that the primary role of the indigenous rangeland management system was to provide survival strategies (26.6%) followed by risk management strategies (21.0%). 20.6% of respondents considered the system primarily held a cultural role, while others reported conservation and rehabilitation (15.1%), flexibility to changing conditions (9.1%), and sustainability (7.3%) as the primary provision of the system (Table 11).

Table 11. Views and role of traditional knowledge of communities in the Guji zone of south Ethiopia, (n=211)

Attributes	Wadera (%)	Gorodola (%)	Liban (%)	Mean (%)
Survival strategy	24.2	24.4	35.9	26.6
Risk management	24.9	22.1	11.7	21.0
Cultural	23.5	17.9	19.3	20.6
Conservation and rehabilitation strategies	14.6	15.7	15.2	15.1
Sustainable	4.6	10.2	7.6	7.3
Flexible to changing conditions	8.2	9.4	10.3	9.1

Number of respondents.2 Stability refers to the degree to which range productivity remains constant despite normal fluctuations in environmental variables.3 Sustainability refers to the ability of the range to sustain its long-term productivity when subjected to particular environmental or management stresses.

Local communities viewed the pastoral production system as facing numerous challenges. 89% of respondents rated that rangelands were found in a downward trend of condition (Table 12). Most informants reported that the current condition of the rangeland (95.3%), grass cover (95.7%), and milk production per animal (98%) had declined. The majority of respondents (73%) indicated grazing land management was less sustainable than the forty years ago and the remaining 28% of respondents suggested that it has been sustainable and more sustainable than forty years ago. Similarly, most of respondents (79.6%) indicated that the grazing land management system was less productive, while the remaining 20% reported it as having been productive and more productive than forty years ago. Furthermore, most respondents (68.8%) replied that the trend of food security had decreased, whereas 28.9% of respondents reported this trend had increased. Only, 3.8% of respondents failed to make suggestion.

Table 12. Perception of communities toward range condition, trend, sustainability, productivity in Guji zone of south Ethiopia (n=211)

Variables	Wadera	Gorodol	Liban	Mean
Assessing rangeland (%)				
Yes	84.6	78.3	60	87.2
No	13.2	21.7	0	11.8
Condition of rangeland (%)				
Good	2.2	8.3	5.0	4.7
Poor	97.8	91.7	95.0	95.3
Trend of rangeland (%)				
Downward trend	90.1	78.3	98.3	89.1
Upward trend	8.8	16.7	1(1.7)	9.0
The same as before	0	5.0	0	1.4
Grass covers (%)				
Increasing	1.1		1.7	1.4
Decreasing	92.3	100.0	98.3	95.7
The same as before	0	0	0	2.8
Milk production per animal (%)				
Declining	97.8	96.7	100	98
Increasing	2.2	3.3	0	2.2)
Sustainability of grazing land management (%)				
More sustainable	2.2	0	15.0	5.2
Sustainable	19.8	11.7	31.7	20.9
Less sustainable	78.0	88.3	53.3	73.0
Productivity of grazing land management (%)				
More productive	0	0	25.0	7.1
Productive	93.4	6.7	30.0	13.3
Less productive	6.6	93.3	45.0	79.6
Trend of food security over the past 40 years (%)				
Increasing	29.7	1.7	55.0	28.9
Decreasing	67.0	98.3	35.0	66.8
I don't known	3.3		10.0	4.3

4. Discussion

4.1. Household demographic characteristics

This study has provided a wealth of information on indigenous range management and pastoralists' views on range degradation in the Guji zone of southern Ethiopia, which will be valuable for development and sustainable range management strategies. The average household family size in the study districts (10.4 people) were higher than that of the Afar and Kereyu pastoralists of eastern Ethiopia (6.74 people) (Abule et al*.,* 2005) and comparable with the family size of 9 people for Borena pastoralists of south-eastern Ethiopia (Eyasu and Feyera, 2010). The higher family size might be linked with the cultural practice of polygamy by most pastoralists and agro-pastoralists of the area. The low-level of education noted in the survey is common to many pastoral areas

of Ethiopia (Abule et al., 2005) and might hinder efforts to achieve technology transfer to the communities. Thus, this calls for the introduction of an education system that will accommodates pastoralist and agro-pastoralist lifestyles. The development of agro-pastoralist communities similar to that in other pastoral areas of Ethiopia (Angassa and Oba, 2008), reflects a change from the traditional pastoral lifestyle. Previous studies (Beriso, 1995; Beriso, 2002) in the Guji zone of southern Ethiopia have indicated that settlement programs implemented during Derg regime in 1980's in the Guji communities brought substantial change, such as the adoption of agro-pastoralism, the promotion of crop cultivation, and implementation of formal education. This expansion of cultivation in the rangelands is most likely a result of an increased food demand for families in pastoral communities due to repeated droughts and large losses of livestock. Another potential reason includes policy changes regarding land use and government interventions such as increased access to improved seed, fertilizer, farm implements and extensions.

As elsewhere in Ethiopian and East-African pastoral groups, households kept more than one species of livestock to secure their livelihood. Holding two or more species with different feeding habits can make more effective use of vegetation, thereby increasing profitability. Furthermore, different livestock species can serve different roles (Solomon et al., 2007); as observed in this study, the sale of livestock and livestock products provided the main source of income (Abate et al., 2010). As elsewhere in Ethiopia and other pastoral areas in east Africa, communal grazing is often the main land use management system in the study area. Productivity of the rangelands was influenced by the availability of desirable plant species and adequate rainfall (Oba et al., 2000), with drought causing feed shortages in terms of season of use (Oba and Kotile, 2001) and grazing capacity (Abule et al., 2005).

4.2. Traditional rangeland management practices

Like other East-Africa pastoral communities in the Guji pastoral system, grazing resources have been owned communally and administered by traditional institution where community leaders/elders formulate bylaws about their use in accordance to the spatial and temporal patterns of grazing and the types of animals to be allowed to graze (Oba, 1998). The uses of range enclosure in the Guji pastoralists were a common practice. Oba (1998) explained that the Boran recently adopted the enclosures from the settled agro-pastoralists of the Guji communities during the *gada* of Gobba Bulle (1960-1968) and expanded the enclosures during the *gada* of Jillo Aga (1968-1976) and Boru Guyo (1984-1992) (Oba, 1998). The decision to establish communal enclosures followed the proclamation of the Assembly of *Gumi Gayo* in 1988 (Tache, 2000). Range enclosures are less developed in the arid lowlands including the Liban district, where conditions are too dry and the population is more nomadic. The establishment of range enclosures was the community's way of a responding to both the scarcity of feed for vulnerable herd classes (e.g.

calves, milking cows and weak animals) and droughts. In the study area, enclosures provide an opportunity to develop a more intensive communal resource management system. Additionally, the establishment and promotion of communal enclosures and drought season reserves in the study areas could help reduce grazing pressure on communal lands, thereby creating access to fodder banks and improving soil restoration for rangeland development. Tache (2010) reported that in the Liban and Gorodola districts, currently 22 communal drought reserve enclosures, which cover about 8, 122.5 hectares, have been established and rehabilitated. Thus, given the inherent uncertainties of arid and semi-arid environments and the current risk of climate change, enclosures and drought reserves can contribute to a local adaptation and mitigation strategies to climate change. However, the recent expansion of farming, settlement, and gradual privatization of the rangelands, are a threat for a mobility-based land use system. This threat arises from neighboring agriculturalists, farming by pastoralists themselves, and urban residents who have a desire to adopt private enclosures for large-scale investments. Furthermore, the problems associated with enclosures in the study area were similar to those reported by Oba (1998), Gemedo-Dalle et al., (2006) in Borana, southern Ethiopia.

As observed in the present study Rendille pastoralists in northern Kenya (Dabasso et al., 2012) and Borana pastoralists in southern Ethiopia (Oba and Kotile, 2001) classified landscapes based on vegetation, soil, and historic events. The eco-physiognomic classification of the grazing landscapes used by the communities in the Guji pastoral area is comparable to the approach used in conventional range science. The local communities classify grazing landscape into *Badaa* and *Gamojii*—wet and dry season grazing—on the basis of climatic factors, topography, dominant plant species and soil type. This criterion is similar to that used by the Ariaal of northern Kenya (Oba, 1994), who classify range into two main categories: the highlands and the lowlands. Furthermore, based on these eco-physiognomic classes, the local communities make decisions pertaining to range suitability for a given livestock species. However, today in the Guji pastoral area, the key dry season grazing areas has been declining due to the expansion of farming, and settlements in most grazing areas of the *Badaa* landscape. As a result, livestock frequently graze on the *Gamoji* landscape. Additionally, respondents explained that continuous grazing has affected the vegetation of the *Gamoji* landscape and desirable grasses species have declined. For example, the abundance of desirable grasses important for cattle such as *Sardoo (Cynodon dactylon), Mata gudeesa (Cenchrus ciliaris)*, *allaloo (Chrysopogon spp), Ilmogorii (Leptothrium senegalense)* have declined. Whereas undesirable and invasive plant species have been increasing. Local communities explained that human activities on the *Gamoji* landscapes such as expansion of farming, settlement, timber and charcoal making, selling of wood for fuel, and deforestation has increased, thereby affecting the availability of forage plants. In the past, no individuals in the Guji communities have used charcoal burning as a livelihood strategy. These types of livelihood activities lead to deforestation, the loss of other ecosystem services, and alter the local climate.

The traditional rangeland and livestock management practices noted in this study split livestock herds based on species, type and productivity. Herd diversification and free ranging of communal land were similar to those

reported from other East-African countries (Oba and Kotile, 2001). Herd diversification in the study area was found to be pastoralists' response to changing environmental conditions, which corresponded to responses by other pastoral areas. Cattle is the dominant herd, and the Guji and the Borana pastoralists' have cultural value for cattle herding. Despite this culture surrounding cattle, today the Guji and the Borana communities have increasingly adopted camel and goat in order to adaptat to persistent drought and pasture decline. The diversification of herd composition is a response to changing environmental conditions and enhances climate resilience in the region. The adoption of camel and goat herding requires the acquisition of new knowledge regarding different patterns of grazing and water use and animal husbandry.

Herd mobility a key strategy in response to spatial and temporal variability of rangeland resources (Oba, 2011). Mobility is used for a wide range of purposes, and the practice relies on pastoralists' knowledge and local institutions for making decisions (Oba, 2011). According to informants, herd mobility was a community survival and risk mitigation strategy. Despite the benefit of mobility for pastoralists and the environment, government policies to date have not promoted its sustainability. Pastoral development policy in Ethiopia emphasizes sedentarization as a way out of poverty, and this policy direction fails to recognize mobility as a means of production in the arid lands. The extent and direction of herd movement, trend of mobility and the problems facing pastoralists in the current study were similar to those reported by Scoones (1995), and Abule et al., (2005). In the study area, pastoralists linked the spatial diversity and abundance of bush and shrub vegetation with free movement of livestock in the communal grazing land, resulting in the dispersal of seeds of different plant species.

4.3. Local level indictors for rangeland degradation

Pastoralists have been able to detect change and describe the status of their rangelands. The degraded sites in this study locally called *kunchayee* and *barbadah*, for overgrazed sites, is also common in Rendille pastoralists in northern Kenya (Dabasso et al., 2012). Guji and Borana pastoralists used many indictors to explain range degradation. Pastoralists described degradation on the basis of overall animal performance (e.g. rumen fill, milk production, weight gain, coat condition, mating frequency and health). The observations about the decline in livestock performance indicators were made at household level and views were shared at the elders' meetings for appropriate decision making. Furthermore, pastoralists depicted range deterioration from the point of protecting their household food (mainly milk), income, and other livelihood requirements. The condition of plant growth and grazing pressure were also inferred from the livestock performance. This implies that range condition can be inferred without directly measuring the indicators. This shows that links among pastoralist, livestock, and their grazing environment could be strong. As

opposed to herder views, ecological assessment of degradation is not coupled with livestock production performance.

Range degradation can be described in terms of vegetation indicators (e.g. poor rangeland condition, vegetation cover, abundance of undesirable plant, presence and absence of valuable forage). The pastoralists associated the availability of desirable grasses with good rangeland conditions while undesirable grasses and forbs with degraded land. The presence and absence of key valuable forage species were used indicators of range degradation rather than using the diversity of entire species. As opposed to pastoral views, ecologists may monitor a few key species to reach decisions on land degradation, while herders used multiple indicators (e.g. Fernandez-Gimenez, 2000; Oba and Kotile, 2001). Most often ecologists might assess degradation from a conservational point of view for the protection and conservation of landscape, which indicates lack of emphasis from a local-land use perspective. This study and others (e.g. Oba, 2001; Dabasso et al., 2012) have indicated that range degradation can be explained in terms of soil erosion. Use of various indicators to describe rangeland degradation is more or less standard across sub-Saharan Africa (Herrmann and Hutchinson, 2005; Mortimore and Turner, 2005), North Africa (Behnke and Scoones, 1993), South Africa (Hoffman et al., 2007), northern Kalahari of Namibia (Katjiua and Ward, 2007), Borana of southern Ethiopia (Gemedo-Dalle et al., 2006; Solomon et al., 2007) and eastern Ethiopia (Kassahun et al., 2008). The poor current range condition and range degradation documented in this study were similar to those found in the Borana rangeland of southern Ethiopia (Solomon et al., 2007 Ayana and Fekadu, 2003), Awash Rift Valley of Ethiopia (Abule et al., 2005).

4.3. Underlying cause and impact for rangeland degradation

Understanding the driving forces behind rangeland degradation in the dry land ecosystems, however, can be complex. Recurrent drought, expansion of crop cultivation, human population growth, settlement, overgrazing, bush encroachment, and bans on use of fire were the main factors attributed to degradation in this study, which corroborates findings of many other studies (Gemedo-Dalle et al., 2006; Solomon et al., 2007). The impact of prolonged drought in the Guji and the Borana pastoralists has been widely documented (Oba, 1998). Periodic drought in the Guji and the Borana communities could induce chronic poverty and local food insecurity (Tache and Oba, 2010) and massive loss of livestock (Cossins and Upton, 1988); this view was supported in the present study. Demographic factors related to human population growth resulting from an increase in the number of communities themselves, settlements, and immigrants from outside the pastoral area are the underlying causes for rangeland degradation. The human population of Guji zone included the study area was about 1,412,972 in 1999 and increased to 1,590,225 in early 2000's years (Addisalem, 2006). Furthermore, the annual human population growth rate in the Borana rangelands including the study area was about 1-1.3% in the early 1970s (Homann et al., 2005), but increased to 2.5% in the 1980s (Coppock, 1994). In the late 1990s, the net population growth was estimated at 3% per year (Helland, 1997). From this, it can be inferred that increases in

human population can aggravate pressure on the existing rangeland resources and lead to land degradation.

Government policies that were identified as the main causes of degradation include: the expansion of cultivation, settlement programs, and bans on use of fire (Beriso, 1995; Beriso, 2002). Fire plays an ecological role in shaping the structure and composition of rangeland vegetation (e.g. Angassa and Oba 2008). Pastoralists traditionally used fire to control the expansion of bush cover and ticks, to improve pasture quality, and to facilitate livestock movements. However, the use of fire was prohibited in the early 1970s (Coppock, 1994). As a result, bush covers have significantly increased (Oba, 1998). In the region, bush encroachment has increased within the last four decades, with negative effects on cattle production and community livelihood (Angassa and Oba, 2008), thereby accelerating the degradation of rangelands. This suggests that inappropriate government development interventions can be linked to rangeland degradation. Rangeland degradation can be described in terms of soil erosion (Oba, 1998; Oba et al., 2000). Soil erosion has become a serious problem in the study area with the formation of bare ground and gullies in many places. The change in pastoral land use has weakened the local traditional institution. As a result, the present condition of resource management practices is not as strong as 3-4 decades ago.

Rangeland degradation in the Guji and the Borana communities has resulted in a substantial change in livestock holding at the household level, while communities in general have lost their livestock asset and become destitute. Another consequence of rangeland degradation is linked to food insecurity, poverty to the extent of food aid, expansion of aridity and the need for alternative livelihood income and diversification, as described by pastoralists in this study, which is in agreement to results found Kassahun et al., (2008) in eastern Ethiopia. In general, our analysis suggests that the problem of rangeland degradation can cause severe poverty for inhabitants of arid environments.

4.4. Herder perception on bush encroachment

Bush encroachment and the expansion of invasive plant species represent significant problems as found elsewhere in the rangelands of Ethiopia (Oba et al., 2000; Angassa and Oba, 2008). Smit (2002) suggested that the causal factors for bush encroachment are complex and have been a contentious issue in rangeland ecology. Pastoralists considered that drought, overgrazing, livestock movement and absence of fire were the main factors causing woody encroachment, which is in agreement with reports by Abule et al., (2005) for the Awash Rift Valley of Ethiopia, Herrmann and Hutchinson (2005) for the Sahelian belt of Africa, Twine (2005) for South Africa, Gemedo-Dalle et al., (2006) and Angassa and Oba (2008) for the Borana zone of southern Ethiopia. There is numerous evidence in the literature that bush encroachment causes a decline in rangeland conditions; the respondents in this study supported this view. The control of bush encroachment will require a proper understanding of

invasive species, the extent of encroachment, the mechanisms leading to their increase, and the population dynamics of the invasive species, which could be used to develop a long-term community-based control program.

4.5. Role of traditional management and system sustainability

As noted in this study the indigenous knowledge of pastoralists is closely related to survival and risk management strategies and provides a basis for local-level decision-making pertinent to rangeland management and various other community-based activities (De Guchteneire et al., 1999). Indigenous knowledge was found to be versatile, and the pastoralists in the Guji zone view rangeland resources in a holistic way. Additionally, the traditional systems recognize and use several kinds of adaptive rangeland management and improvement techniques. For instance, the use of range enclosure as an adaptive response to scarcity of pasture and drought management, division of herds into home based (*waara*), and mobile (*foora*) herds managements system, partition of grazing land into wet and dry seasons, mixed-species herds to use of all ecological niches; mobility to disperse grazing pressure, classification of rangeland at macro landscapes level, rangeland monitoring and assessment knowledge (e.g. range condition, and range degradation), use of *hayyaa* soil for minerals supplementation, and the knowledge of plant-animal interactions. Furthermore, pastoralists have developed well-established rules and regulations for resource uses (e.g. pasture and water resources). These are some of the examples that indicate the importance of indigenous ecological knowledge in sustainable resource management. Indigenous knowledge enables pastoralists to survive and adapt in their unpredictable environments. Currently, communities reported that the pastoral production system faced numerous challenges and has become increasingly unsustainable (e.g. rangeland degradation, recurrent drought, food insecurity, and poverty). This implies that the rangeland management system is becoming unstable, and pastoral livelihood is more insecure. Furthermore, this study supported that the undermining indigenous knowledge, which was comparable to scientific knowledge (Oba and Kotile, 2001) was the main cause for rangeland degradation and a threat to the livelihood of pastoralists in the region.

5. Conclusion and Recommendations

The results of this study can be relevant for the development and sustainable management of rangelands in arid environments. The finding shows communities have a well-developed and effective assessment and monitoring system. The study reveals communities recognize and use several kinds of traditional rangeland management practices including: range enclosures, seasonal herd mobility, herd diversification, partitioning of grazing lands into wet and dry season. These kinds of rangeland management practices can play a key role in sustainable management and conservation of range resources. The study shows that communities used numerous indicators to explain local level range degradation, encompassing: livestock, soil, vegetation, and water and

termite infestation. The causes for degradation were identified to be drought, expansion of crop cultivation, settlement, and human population growth. Consequently, degradation may contribute to the decline in household livestock asset, the expansion of aridity, food insecurity and poverty, the weakening of local institutions, and increased community engagement in alternative livelihood income and diversification options. The study shows an alarming increase in degradation and the urgency of measures to halt this trend. Additionally, the current condition of rangelands can be enhanced through rehabilitation, conservation, and management. This would involve the strengthening of seasonal herd mobility, herd diversification, strengthening of enclosures and drought reserve pastures in key sites. In these regard, enhancing traditional resource management systems and technological support to pastoralists is recommended. Full participation from all stakeholders (public community, policy makers, development practitioners and researcher) who may be directly or indirectly involved in rangeland resource management and conservation is imperative. Furthermore, to minimize the pressure on rangeland resources, various stakeholders should emphasize education regarding livestock market, the design of income generation, and livelihood diversification options. Additionally from this study, the following points are also concluded: (i), community-based knowledge can be a key element for sustainable management and conservation of resources in arid and semi-arid environments, (ii) community knowledge can be vital to understanding environmental change at a local-level and effective in the development of an assessment and monitoring system (iii) local knowledge can provide a basis for making holistic decisions pertinent to rangeland management, enhance local institutions and encourage local communities to range rehabilitation, (iv), community based knowledge should be integrated into a scientific approach to understand the degradation and to develop tools for a monitoring system.

Acknowledgements

The research work was financed by the Office of Research, Dissemination, and Community Services of Dilla University, Ethiopia. I thank Agriculture development workers specially Samuel Abomssa, Birbissa, Tutishe, Samuel Bekele, Abiyot Mesifin and enumerators. I also thank the Guji elders for their time and kindness in willing to share their accumulated knowledge and experience on overall rangeland management and degradation in the study area.

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