Landscape Ecology vol. **9** no. 2 pp **79-88 (1994)**
SPB Academic Publishing bv, The Hague

Pastoralism and plant cover in the lower Shabelle region, Southern Somalia

Ahmed M.I. Barkhadle', Luca Ongaro[1] and Sandro Pignatti[2]
[1]*Istituto Agronomico per l'Oltremare, Via A. Cocchi,* **4,** *I-50131 Firenze, Italy;* [2]*Dipartimento di Biologia Vegetale, Università degli Studi di Roma 'La Sapienza', Citta Universitaria, Piazzale Aldo Moro,* **5,** *I-00185 Roma, Italy*

Keywords: Somalia, rangeland, vegetation

Abstract

A vegetation and rangeland survey has been carried out in the lower Shabelle region, Southern Somalia, with the aim of evaluating the natural vegetation as a source of forage for grazing animals. In this framework, four different vegetation types have been recognized and mapped using remote sensing techniques; general vegetation characteristics, mainly floristic and physiognomic aspects, are described. Dynamic relationships between these vegetation types are also outlined.

1. Introduction

As compared to the neighbouring countries Somalia has remained almost unknown from the vegetational and ecological point of view; phytosociological notices, plant communities distribution and vegetation maps are rather scarce. Ciferri (1939), and Moggi (1987) described some coastal marine communities; Raimondo and Warfa (1980), Pignatti and Warfa (1983) conducted some phytosociological researches in the Benadir region. Pichi-Sermolli (1957) first mapped the main vegetation types of Horn of Africa, while White (1983) included this region in his vegetation map of Africa discussing the main vegetation formations, mostly derived from the literature; De Marco and Fagotto (1978), Barkhadle (1992) mapped the vegetation of lower Shabelle region using respectively 1:100.000 and 1:50.000 scales. On the other hand Knapp (1973), Wieland and Werger (1985), Friis and Vollesen (1989) described some Somali vegetation types. In arid and semi-arid countries like Somalia drought frequency is actually increasing, (FAO 1986); every 3–5 years shorter droughts are observed and every ten years a disaster drought occurs. Population is also increasing rapidly; in Somalia in 1975 there were only 3.5 million inhabitants, in 1988 this figure rose to 8.5 million persons, probably some of them refugees from Ethiopia. The drought frequency and the intensity of use by human beings and their animals caused a heavy impact on the Somali natural vegetation.

The natural vegetation is thus suffering extreme degradation due to overgrazing, intensive collection of fuelwood, charcoal and building materials, while the agriculture is more and more expanding into the rangelands.

A research project was started in 1989, with the aim of establishing a methodology for rangeland evaluation and mapping, including grazing capacity estimation; this parameter, in fact, is one of the most important factors for range management planning and improvement. In this framework, a vegetation survey has been carried out over a test area, and the results are presented here.

2. Description of the study area

The study area covers about 900 km^2 in the Marka and Qoryooley Districts (lower Shabelle region), Southern Somalia, and is located between 44°30′ and 44°45′ East and between 1°45′ and 2°00 North. About 60% of the area is agriculture land and 40% rangeland. It is one of the more densely populated areas of the country, and one with the most favourable climatic conditions (45,000 Ethiopian refugees were present).

2.1. Geomorphology and geology

The landscape is uniformly flat, with elevation of about 80 m, covered by recent alluvial soils. The study area encompasses the Shabelle river, originated from Ethiopian highlands, that flows for about 1100 km in the Somali territory, with a 300,000 km^2 catchment basin.

2.2. Climate

The climate of Somalia is dominated by the alternative monsoons of North-East, blowing from the Asian coasts, and South-West.

2.2.1. Precipitation

Climatically the year is divided into four seasons. The main rainy season in Somalia is 'Gu', normally between March and June, while the second rainy season occurs from September to November and is called 'Deyr'. The dry seasons are from January to April ('Jilaal'), and from July to mid September ('Xagaay').

In the lower Shabelle region the average precipitation in the 'Gu' season is 200–250 mm while in the 'Deyr' season the rain is about 100–150 mm; and sometimes a very small amount of rain falls in 'Xagaay' season. The mean annual precipitation reaches 350–600 mm; rainy days are 55–65, mostly in the 'Gu' season.

2.2.2. Temperature

Somalia, being an Equatorial region, has a hot climate with temperature always between 25°C and 35°C. In the study area the mean annual temperature varies from 25°C to 27°C, almost constant all round the year, while the relative humidity is more than 80% and the data can be higher when the monsoons are not blowing. The hottest months are March and April, while the coolest ones are from June to August.

2.3. Natural vegetation

The study area includes the Interfluvial zone, more favoured climatically as compared to the rest of the country, and vegetationally rich. Pichi-Sermolli's (1957) map reports it as a xerophyllous bushland; White (1983), Friis and Vollesen (1989) classified the vegetation of the area as *Acacia-Commiphora* bushland, while Barkhadle (in press) in his 'Traditional 'Deegaan' (Ecological zones) classification map' considered it as a Dhobooy land ('Dhulka Dhobooy') where the maximum concentration of agricultural and pastoral activities are found.

2.4. Human activities

In the study area the people are mostly farmers and pastoralists. Along the river there are intensive agricultural activities; maize, paddy rice, beans, sesame, vegetables are grown, along with perennial crops, mainly bananas and citrus plants, while the small dryland farmers or sporadically pastoralists cultivate sorghum or maize along the border between agricultural land and bushland, far away from the irrigated area or rarely in the bushland using shifting cultivation.

3. Methods

Satellite images (Landsat 4, Thematic Mapper, acquired on 8th February 1989, in the 'Jilaal' dry season being the last available and clean from cloud cover) were utilized for preliminary main landscapes separation. The image has been elaborated at the Istituto Agronomico per l'Oltremare (IAO)

Remote sensing laboratory. Visible and infrared bands have been combined and enhanced to produce different false colour composit (FCC) for visual interpretation. A normalized difference vegetation index (NDVI) has been also calculated. To have more detailed information on vegetation and land use, photointerpretation has been carried out also on black and white panchromatic aerial photography at the scale of 1:30.000, (flight of 7th March 1983). From the above material, a preliminary vegetation/land cover map has been produced at the scale 1:50.000.

June and July 1989 and July 1990 were spent for full ground confirmation of land units and vegetation types.

The vegetation was sampled and classified according to the phytosociological methods of Braun-Blanquet (Werger 1974; Muller-Dombois and Ellenberg 1974). Vegetation data: species presence, cover-abundance per layer including observations on physiognomy and structure of vegetation, life-forms and plant phenology were collected at 35 sample sites. Observation has been made also on the grazed percentage, for each species, using an adequate symbolic scale (Barkhadle 1992). Some environmental data mainly related to precipitation, geomorphology and soils were also collected. For each sample site a soil sample has been collected and analyzed for the major soil factors.

Due to the overlapping of vegetation strata some methodological modifications were required to obtain the representative minimum sampling size and cover-abundance scale. In the very dense vegetation type, dominated by woody plants, samples of 400 m^2 have been used, while in the heavily degraded open vegetation type, dominated by the herbaceous layer, samples of 800 m^2 have been used.

The following cover classes and symbols are used: + = rare and cover less than 1%; 1 = cover 1–5%; 2 = cover 6–10%; 3 = cover 11–15%; 4 = cover 16–20%; 5 = cover 21–40%; 6 = cover 41–70%; 7 = cover 70–100%. This non-conventional scale has been adopted for a better evaluation of covers under 20%, very common in the study area. This scale is also pseudo-linear to allow the use of the same data for grazing capacity estimation. The sum of cover values of some samples higher than 100% is justified by the overlapping stratifications.

The resulting matrix of 143 plant species (columns) and 35 samples (rows) has been processed using the MULVA-4 (Wildi and Orloci 1989) software system. First, two similarity matrixes have been computed (between species and between samples), using the similarity coefficient of van der Maarel, then samples have been grouped using a complete linkage clustering. From this first grouping, a sharp separation has been noted between the floristic composition of irrigated agricultural areas and bushland. Thus, the bushland samples were elaborated separately, and ordinated according to their degradation gradient.

Life forms have been classified in three groups that are easily recognizable in the Somali bushland:

a) trees and woody shrubs (> 1 m tall),

b) dwarf shrubs and forbs (< 1 m tall),

c) grasses and sedges.

400 plant samples were collected, recording also their vernacular names. They have been identified in the Tropical Herbarium of Florence, Italy, using the nomenclature of Cufodontis (1953 – 1972) and Kuchar (1988).

During the field work the number of browsed and grazed species were observed and the percentage of the consumed part was estimated for each species. The stocking rate and potential grazing capacity were also calculated.

4. Results

4.1. General vegetation description

According to land use the study area can be classified as agricultural land (about 60%) and rangeland (40%). The natural vegetation has been divided in five main classes, physiognomically identifiable both in satellite image and aerial photography:

I – Rangeland: the vegetation of the rangeland is rather homogeneous, so that it can be considered belonging to three different facies of the same association.

a) Dense bushland, with slightly or no degraded vegetation with association of *Combreturn here-*

Table I. Lifeform frequencies in the different vegetation types.

Vegetation type	Number of species	Trees and w/shrubs	D/shrubs and forbs	Grasses and sedges
Slightly degraded bush	25	10	12	13
Moderately degraded bush	21	8	10	3
Heavily degraded bush	19	6	9	4
Agricultural area	23	2	12	9

roense and *Grewia tenax* (natural community)

b) Open bushland, with moderately degraded vegetation with association of *Combretum hereroense* and *Grewia tenax (Acacia zanzibarica* community)

c) Open bushland, with heavily degraded vegetation with association of *Combretum hereroense* and *Grewia tenax (Acacia nubica* and *Pupalia lappacea* community)

2 – Agricultural land: in the agricultural land there are two main communities:

a) The vegetation of the cultivated and fallow areas *(Psoraleacorylifolia* and *Heliotropium steudneri* community)

b) The vegetation of the riparian forest *(Ficus sycomorus, Mimosops degan* and *Acacia stenocarpa* community, (De Marco and Fagotto 1978), small pockets included in the agricultural land.

4.1.1. Physiognomy, species diversity, and lifeforms

The Southern Somalia bush vegetation is highly influenced by anthropic actions such as overgrazing, cutting of woody biomass for fuel etc. In general the high density of trees and woody shrubs indicates the climax stage of the bush vegetation. Trees and woody shrubs decrease with heavy negative anthropic actions, while the number of forbs and grasses increases.

Table 1 indicates how the average number of species and lifeforms of each vegetation type varies with human activities.

In the more disturbed agricultural area there is an average of only two species of wild trees and woody shrubs in each sample, very rich in forbs and grasses, while the less influenced dense bush has the larger number of species, dominated by trees and woody shrubs.

The correlation between human activity and vegetation degradation in the arid and semi-arid environment can be seen very clearly in the Somali rangelands, where the number of species and vegetation density decrease with the increase of the grazing activity. The ordination of samples and species showed that the climax association of *Combretum hereroense* and *Grewia tenax* can have two degraded *facies;* the first (moderately degraded) is characterized by the presence of *Acacia zanzibarica,* the second facies (highly degraded) is characterized by *Acacia nubica* and *Pupalia lappacea.* It was also noted that when the degradation of the natural vegetation increases, the presence of *Combretum hereroense* and *Grewia tenax* decreases, and a general decrease of the total vegetation cover occurs.

Species diversity in the study area is relatively high, when compared with similar areas. In total, 143 species were collected, of which 44 species are trees and woody shrubs, 77 are dwarf shrubs and forbs and 22 are grasses and sedges. During the field survey plant phenological stages were observed, with particular regard to the presence of leaves, flowers and fruits of each species in the different vegetation types.

During the early dry 'Xagaay' season, almost all plant species were vegetatively active, but only 29 species had flowers and fruits.

Later in the 'Xagaay' season, all plants are expected to shed leaves except evergreen families like *Salvadoraceae, Capparidaceae* etc.

4.1.2. Cover

Average total cover by vegetation type varies with moisture availability and intensity of human presence. The *Combretum hereroense* and *Grewia tenax* community (slightly degraded bushland) has

Table 2. **Dense bushland vegetation with slightly or no degraded vegetation with association of** *Combretum hareroense* **and** *Grewia tenax.*

RELEVE' GROUP N°	4	4	4	4	4	4	4	4	4	4	4	4	4	4
RELEVE' N°	27	28	32	83	33	33	30	02	12	21	19	41	12	06
Grewia tenax	3	3	3	2	1	2	2	3	3	3	4	4	3	3
Dobera glabra	1	1	1	3	3	2	2	+	2	2	1	2	2	2
Combretum hereroense	1	2	3	2	2	2	1	4	4	3	4	2	+	
Acacia Zanzibarica	3	.	2	2	1	3	2	1	2	+	1	1	3	
Acacia bussei	+	+	2	+	.	2	+	1	3	3	1	3	3	
Cordia sinensis	2	+	2	2	+	1	+	1	2	.	3	1	+	
Sporobolus helvolus	1	3	2	1	3	1	2	3	4	.	2	2	3	
Dichrostachys cinerea	.	4	.	1	.	+	2	2	1	.	3	+	3	
Grewia villosa	.	.	+	1	+	+	+	.	1	.	2	+	1	
Maerua angolensis	+	.	+	+	+	+	+	.	1		+	.	+	
Sporobolus sp.	.	3	+	1	1	.	2	4	.	.	1	2	2	
Salvadora persica	l	.	+	3	.	.	+	.	2	2	+	1	.	
Hibiscus aponeurus	.	.	+	+	+	2	.	+	2		+	l	.	
Acalypha volkensii	+	+	+	1	.	.	1	.	.	+	+	.	+	
Boscia coriacea	.	.	+	+	+	+	.	.	1		.	+	l	
Thespesia danis	.	.	.	+	+	.	.	+	+		+	.	1	
Acacia mellifera	.	.	.	+	.	+	+	1	1		.	l	.	
Pavonia elegans	.	+	.	+	+	2	.	.	.		.	+	l	
Sansevieria robusta	+	.	+	.	+	.	+	.	1		.	.	l	
Tetrapogon villosus				.	.	2	2	.	2	+	+	.	+	
Commiphora sp.	.	.	.	.	+	.	+	.	+		.	+	+	
Neuracanthus sp.	.	.	.	1	+	.	+	.	.		2	.	+	
Indigofera schimperi	.	.	l	+	.	+	+	.	.		.	+	.	
Celosia polystachia	.	+	.	.	+	.	+	1	.		.	.	.	
Phyllanthus somalensis	+	+	.	.	.	.	.	.	3		.	.	2	
Coffea rhamnifolia				.	.	.	.	.	1		+	+	+	
Justicia baravensis	+	.	.	.	.	.	+	.	.		l	.	+	
Blepharis ciliaris	.	.	.	+	.	3	+	.	.		.	.	2	
Dactyloctenium aegyptium	.	.	.	1	.	.	+	+	.		.	.	+	
Dactyloctenium scindicum				.	.	2	+	.	2		.	.	+	
Cordia monoica				.	.	+	+	.			+	.	.	
Acacia reficiens				.	.	.	.	+		+				
Commiphora campestris	+	.	.	.	.	.	.	+	.	.	+	.	.	
Boscia flavescens	.	.	.	.	.	.	+	+	.	.	.	.	+	
Pentatrops sp.	.	.	.	.	.	.	t	.	.	.	.	+	+	
Vernonia cinerascens	.	.	.	.	.	1	+	.	.	.	.	.	2	
Brachiaria leersioides	.	.	.	.	.	.	3	.	.	.	+	.	1	
Cynpdon *dactylon*	.	.	+	.	.	.	.	.	.	1	.	+	.	
Cymbopogon sp.	.	.	.	+	.	+	.	.	2	.	.	.	.	
Clerodendrun hildebrandtii	.	.	.	.	.	.	.	+	.	.	.	+	.	
Maerua scebellensis	.	.	.	1	.	.	.	.	.	.	.	.	1	
Commiphora ellenbechii	.	.	.	.	.	.	.	.	.	.	+	.	+	
Cadaba heterocricha	.	.	.	.	.	.	.	.	+	.	.	.	+	
Acacia nilotica	.	.	.	.	.	.	.	.	1	.	+	.	.	
Commiphora incisa	t	.	+	.	.	.	.	.	.	.	.	.	.	
Commiphora schimperi	.	.	.	.	.	+	.	.	1	.	.	.	.	
Rhynchosia sublobata	.	.	.	.	.	.	.	.	1	.	.	.	1	
Pupalia lappacea	.	.	.	.	.	.	+	+	.	.	.	.	.	
Acalypha fruticosa	.	.	.	.	.	.	.	.	2	.	.	.	2	
Adenium obesum	+	.	.	.	.	.	.	.	1	.	.	.	.	
Chrysopogon aucheri	.	.	.	.	.	.	.	+	.	.	.	.	3	
Acacia- nubica	.	.	.	.	.	.	+	.	.	.	.	.	.	
Terminalia brevipes	.	.	.	.	.	.	.	.	1	.	.	.	.	
Grewia kokothamus	.	.	.	.	.	+	.	.	.	.	.	.	.	
Euphorbia granulata	+	.	.	.	.	.	.	.	.	.	.	.	.	
Cadaba baccarinii	.	.	.	+	.	.	.	.	.	.	.	.	.	
Maerua subcordata	.	.	.	.	.	.	.	.	.	.	.	+	.	
Commiphora hodai	.	+	.	.	.	.	.	.	.	.	.	.	.	
Heliotropium cinerascens	.	.	+	.	.	.	.	.	.	.	.	.	.	
Seddera hirsuta	.	.	.	.	.	.	.	.	1	.	.	.	.	
Ocimum superbum	.	.	.	.	.	.	.	.	.	+	.	.	.	
Allophylus rubifolius	.	.	.	.	.	.	.	.	.	.	.	+	.	
Solanum incanum	.	.	.	.	.	1	.	.	.	.	.	.	.	
Ecbolium viride	.	.	.	.	.	.	.	.	.	.	.	.	1	
Allophylus alnifolius	.	.	.	.	.	.	.	.	+	.	.	.	.	
Sesbania sesban	.	.	.	.	.	.	.	.	.	+	.	.	.	
Kedrostis sp.	.	.	.	.	.	.	.	.	1	.	.	.	.	
Sarcostemma andongense	.	.	.	.	.	.	.	.	+	.	.	.	.	
Cissus rotundifolia	.	.	.	.	.	.	.	.	t	.	.	.	.	
Priva cordifolia														
Cissus digitata	.	.	.	.	.	.	.	.	.	.	.	.	+	
Sida ovata	.	.	.	.	+	.	.	.	.	.	.	.	.	
Commicarpus africanus	.	.	.	.	.	.	1	.	.	.	.	.	.	
Lantana trifolia	.	.	.	.	.	.	+	.	.	.	.	.	.	
Rhynchosia malacophylla	.	.	.	.	.	.	+	.	.	.	.	.	.	
Asystasia schimperi	.	.	.	.	.	.	+	.	.	.	.	.	.	
Seddera latifolia	.	.	.	.	.	.	.	.	.	.	.	.	+	
Flueggea virosa	.	.	.	.	.	+	.	.	.	.	.	.	.	
Asparagus falcatus	.	+	.	.	.	.	.	.	.	.	.	.	.	
Cyclocheilon somaliense	.	.	.	.	.	.	.	.	.	+	.	.	.	
Cryptolepis orbicularis	.	.	.	.	.	.	.	.	.	+	.	.	.	
Nymphaea lotus	.	.	.	.	.	.	.	.	.	.	.	.	.	
Justicia €lava	+	.	.	.	.	.	.	.	.	.	.	.	.	
Solanum somalense	.	.	.	.	.	.	+	.	.	.	.	.	.	
Brachiaria reptans	.	.	.	.	.	.	.	.	1	.	.	.	.	
Enteropogon macroscachyus	+	.	.	.	.	.	.	.	.	.	.	.	.	

Table **3. Moderately degraded vegetation with association of** *Combretum hereroense* **and** *Grewia tenax, (Acacia zanzibarica* **community).**

RELEVE' GROUP NO.	3	3	3	3	3	3	3	3	3	3
RELEVE' NO.	31	23	55	39	12	17	16	64	29	
Cordia sinensis	1	2	+	2	+	+	2	+	2	+
Acacia zanzibarica	3	3	4	2	3	1	3	.	3	4
Maerua angolensis	1	1	.	2	1	+	1	1	+	1
Grewia tenax	.	1	.	3	+	+	2	3	2	1 +
Dobera glabra	1	.	2	.	2	+	2	1	- +	1
Hibiscus aponeurus	2	1	.	+	+	+	+	.	+	+
Sporobolus helvolus	3	2	3	1	2	.	3	.	3	1
Dichrostachys cinerea	1	+	1	.	.	+	2	+	+	.
Grewia villosa	.	+	+	1	+	+	2	.	+	.
Acacia bussei	1	2	.	.	.	1	+	+	+	1
Thespesia danis	1	+	+	.	+	+	.	+	.	+
Salvadora persica	2	2	1	.	+	+	.	.	+	2
Sporobolus sp.	+	2	3	.	+	.	+	.	+	2
Indigofera schimperi	.	.	+	1	+	+	1	+	.	.
Boscia coriacea	1	.	.	+	+	+	.	.	+	.
Combretum hereroense	.	.	+	.	.	.	1	+	1	2
Acacia nilotica	.	+	+	+	+	.	.	.	+	.
Justicia baravensis	.	.	+	+	+	.	+	.	.	+
Dactyloctenium aegyptium	.	+	.	1	+	.	.	.	+	+
Tetrapogon villosus	.	.	.	1	+	1	1	2	.	.
Acacia nubica	.	+	1	+	.	1	.	.	.	.
Commiphora sp.	.	.	.	.	.	.	+	+	+	.
Neuracanthus sp.	.	.	+	.	1	.	+	.	.	.
Acalypha volkensii	.	+	.	.	.	.	2	.	1	.
Pupalia lappacea	+	+	+	.	.	.	.	.	.	.
Celosia polystachia	1	1	+	.	.	.	.	.	.	.
Ocimum basilicum	1	.	.	.	.	.	.	1	+	.
Flueggea virosa	.	.	.	.	+	+	.	+	.	.
Dactyloctenium scindicum	.	.	.	2	3	.	3	.	.	.
Brachiaria leersioides	.	.	.	+	+	.	+	.	.	.
Phyllanthus somalensis	.	.	.	.	.	.	.	l	+	.
Maerua scebellensis	.	.	.	+	.	+	.	.	.	.
Acacia sp.	.	.	.	.	.	.	+	.	+	.
Achyranthes aspera	.	.	.	+	1	.	.	.	.	.
Pavonia elegans	.	1	.	.	.	.	.	.	+	.
Alternanthera sessilis	.	.	.	.	+	.	2	.	.	.
Abutilon benadirense	.	.	3	.	.	.	+	.	.	.
Sida ovata	.	+	+	.	.	.	.	.	.	.
Cardiospermum halicacabum	.	.	.	.	.	+	.	+	.	.
Cynodon dactylon	.	.	.	.	.	+	.	2	.	.
Cymbopogon sp.	.	.	.	.	.	.	.	.	+	+
Clerodendrun hildebrandtii	.	.	.	.	.	.	+	.	.	.
Acacia reficiens	.	.	.	.	+	.	.	.	.	.
Newtonia erlangeri	.	.	.	.	.	.	+	.	.	.
Commiphora campestris	.	.	.	.	.	.	.	.	.	+
Cadaba baccarinii	.	.	.	.	.	.	1	.	.	.
Maerua subcordata	.	.	.	.	.	.	1	.	.	.
Anisotes trisulcus	.	.	.	.	.	.	.	.	+	.
Ocimum superbum	.	.	.	.	.	.	.	+	.	.
Rhynchosia sublobata	.	.	.	+	.	.	.	.	.	.
Allophylus rubifolius	.	+	.	.	.	.	.	.	.	.
Sansevieria robusta	.	.	.	+	.	.	.	.	.	.
Ecbolium viride	.	.	.	.	+	.	.	.	.	.
Blepharis ciliaris	.	.	.	.	.	.	.	2	.	.
Pentatrops sp	.	.	.	.	.	+	.	.	.	.
Priva cordifolia	.	.	.	.	.	1	.	.	.	.
Cissus digitata	.	.	.	.	.	+	.	.	.	.
Tacca leontopetaloides	.	.	.	.	+	.	.	.	.	.
Asparagus falcatus	.	.	.	.	.	+	.	.	.	.
Vernonia cinerascens	.	.	.	.	.	+	.	.	.	.
Nymphaea ***lotus***	.	.	.	.	.	.	.	.	+	.
Pavonia .propinqua	.	.	+	.	.	.	.	.	.	.
Chrysopogon aucheri	.	.	.	.	.	.	.	.	+	.

the highest vegetation cover (90%), while the *Acacia zanzibarica* community (moderately degraded bush) has a cover of about 60%, and in the *Acacia nubica* and *Pupalia lappacea* community (heavily degraded bushland) the average cover drops to *35%*.

In the *Psoralea corylifolia* and *Heliotropium steudneri* community, in the agricultural land where water availability is higher, the vegetation cover scores more than 100%, and is dominated by herbaceous species (weed association).

4.2. Habitat and plant communities description

4.2.1. Slightly degraded vegetation, *Combretum hereroense* and *Grewia tenax* community

The general features of this vegetation have been described by Pichi-Sermolli *(1957)* as Xerophylous bushland, while White *(1983)* refers to it as the *Acacia-Commiphora* deciduous bushland and thicket in the Somali-Masai regional centre of endemism; this type of vegetation approaches to the climax stage of bushland.

The characteristic species of this community are *Combretum hereroense (Combretaceae), Grewia tenax (Tiliaceae)* and *Acacia bussei (Mimosaceae)* with *100%* frequency. The more important families are: *Mimosaceae, Capparidaceae, Tiliaceae, Combretaceae, Boraginaceae, Salvadoraceae, Rubiaceae, Papilionaceae, Acanthaceae, Amaranthaceae, Malvaceae, Graminaceae* (Table *2)*.

The vegetation is very dense, the upper layer is dominated by *3–6* m tall trees and woody shrubs.

The species found are *39%* trees and woody shrubs; dwarf shrubs and forbs are 49%, while grasses and sedges are only *11%*.

The total average cover varies from *70* to *90%* while the upper layer covers about *58%*.

Human activities: The limiting factor of land use is water availability, as it is mostly far away from inhabited centres and water points. The vegetation is browsed exclusively by camels and wild animals; the total average grazing intensity varies from *10* to 20%, according to the grazing percentage scale used by Barkhadle *(1992)*. Fuelwood, charcoal and house construction materials are also sporadically collected; potentially this type of land could be used for extensive cropping, after bush clearing: but this should not be recommended.

4.2.2. Moderately degraded vegetation, *Acacia zanzibarica* community

Due to extensive anthropic activities, the dense vegetation changes into open vegetation of *Acacia zanzibarica.* Species composition shifts towards an increase of dwarf shrubs, forbs, grasses and sedges (see Table *3)*, while the average cover varies from 65 to *70%*. Trees and woody shrubs layer decrease to 39%.

The character species are: *Acacia zanzibarica* and *Dactylocfenium scindicum* accompanied by *Salvadora persica, Dobera glabra, Cordia sinensis, Maerua angolensis, Sporobolus helvolus, Hibiscus aponeurus* etc.

Camels and goats commonly browse and sometimes also sheep and cattle graze during the wet season. The total grazing rate varies from *20* to 30%, and shifting cultivation can also be seen. If water is available, intensive cattle and extensive crop production is potentially possible.

4.2.3. Heavily degraded vegetation *(Acacia nubica* and *Pupalia lappacea* community)

This community can be seen in the heavily degraded bushland, dominated by non-palatable species. The number and density of trees and woody shrubs decreases with the intensity of the anthropic actions; after heavy grazing, the *Acacia zanzibarica* community changes into the *Acacia nubica* and *Pupalia lappacea* community. The forb and grass species are *40%* and *19%* respectively, while trees and woody shrubs represent only *33%* (Table *4)*.

This unit has the lowest vegetation cover (40%), comparing to the dense and open bushland. The trees and woody shrubs layer covers about only *6%*.

This community, on clay-loam soils, seems to undergo the same anthropic actions as the *Calotropis procera* community described by Raimondo and Warfa (1982), on the sandy soils near Mogadishu.

This overgrazed community is generally found near water points and inhabited centres, where the land degradation is high, and eolic soil erosion is also occuring.

***Table 4*. Heavily degraded vegetation with association of *Combretum hereroense* and *Grewia tenax (Acacia nubica* and *Pupalia lappacea* community).**

RELEVE' GROUP N°	2	2	2	2	2	2
RELEVE' N°	1 8	2 3 4	3 4	8	3 0	2
Dichrostachys cinerea	+	+	+	+	1	+
Acacia nubica	+	+	+	1	1	+
Maerua angolensis	2	1	1	+	1	1
Cordia sinensis	+	1	1	+	+	+
Pupalia lappacea	1	+	1	1	2	+
Acalypha volkensii	.	+	+	+	+	3
Acacia zanzibarica	+	.	+	+	.	2
Dobera glabra	.	.	+	+	1	+
Hibiscus aponeurus	.	.	1	2	2	3
Indigofera schimperi	1	.	+	+	+	.
Sporobolus helvolus	.	3	3	+	.	4
Grewia tenax	+	.	.	+	+	.
Grewia villosa	.	.	+	.	+	+
Salvadora persica	+	.	1	.	3	.
Pavonia elegans	.	3	.	+	.	3
Celosia polystachia	.	+	.	+	1	.
Ocimum basilicum	1	+	3	.	.	.
Cynodon dactylon	3	.	.	.	4	1
Acacia bussei	.	.	.	+	+	.
Boscia coriacea	.	.	+	.	+	.
Phyllanthus somalensis	.	.	.	1	.	2
Abutilon benadirense	.	4	.	.	+	.
Dactyloctenium aegyptium	.	4	.	3	.	.
Dactyloctenium scindicum	.	.	.	2	.	2
Brachiaria leersioides	.	.	.	3	.	3
Tetrapogon villosus	+	.	.	.	.	t
Panicum repens	.	.	+	.	.	1
Thespesia danis	.	.	.	+	.	.
Clerodendrun hildebrandtii	.	.	.	+	.	.
Grewia arborea	.	.	.	+	.	.
Euphorbia granulata	.	.	.	+	.	.
Maerua subcordata	.	.	.	+	.	.
Acacia nilotica	.	.	.	+	.	.
Solanum arundo	.	.	+	.	.	.
Neuracanthus sp.	.	.	.	.	.	+
Achyranthes aspera		.	.	2	.	.
Justicia baravensis	.	.	1	.	.	.
Ocimum superbum	.	.	.	+	.	.
Allophylus rubifolius	.	.	.	1	.	.
Solanum incanum	.	.	.	.	.	2
Alternanthera sessilis	.	.	+	.	.	.
Kedrostis sp.	.	.	.	.	.	1
Indigofera tinctoria	.	1	.	.	.	.
Portulaca quadrifida	.	.	.	.	.	+
Zaleya pentandra	.	.	.	+	.	.
Asystasia schimperi						
Ipomoea obscura				t		
Seddera latifolia	+	.	.	.	.	.
Cucumis halabarda	.	.	.	.	.	1
Cyclocheilon somaliense	+	.	.	.	.	.
Cardiospermum halicacabum	+	.	.	.	.	.
Sporobolus sp.	.	.	.	.	4	.
Cymbopogon sp.	.	.	.	.	.	3
Chrysopogon aucheri	.	.	.	+	.	.

***Table 5*. *Psoralea corylifolia* and *Heliotropium steudneri* weed community of abandoned agricultural areas.**

RELEVE' GROUP N°	1	1	1	1	1	1
RELEVE'N°	2 0	1 4	2 6	1 5	5	4
Achyranthes aspera	+	3	3	+	2	1
Dactyloctenium aegyptium	1	3	1	3	2	3
Sorghum arundinaceum	1	+	2	+	1	5
Psoralea corylifolia	4	3	4	3	3	.
Panicum repens	2	2	1	3	3	.
Brachiaria reptans	.	2	1	+	1	2
Heliotropium steudneri	.	.	4	5	2	4
Launaea cornuta	+	.	.	+	+	+
Serra incana	3	2	2	3	.	.
Brachiaria leersioides	.	+	.	2	2	2
Echinochloa haploclada	.	.	+	3	2	+
Cyperus alopecuroides	+	2	2	+	.	.
Cynodon dactylon	2	3	4	3	.	.
Cyperus compressus	2	.	1	3	2	.
Heliotropium cinerascens	.	+	3	.	+	.
Launaea nigricola	.	.	.	+	1	+
Solanum terminale	.	+	.	2	1	.
Cassia occidentalis	.	+	+	2	.	.
Abutilon benadirense	.	.	+	.	+	1
Thespesia danis	.	.	.	.	2	1
Vigna vexillata	.	1	.	+	.	.
Ocimum basilicum	.	.	.	.	1	1
Pergularia daemia	.	.	.	.	+	+
Sesbania sesban	.	3	.	.	.	+
Cuccinia grandis	.	.	.	+	.	1
Rhynchosia velutina	.	.	.	.	+	2
Teramnus labialis	.	2	.	+	.	.
Indigofera tinctoria	.	.	.	+	+	.
Cynanchum sp.	.	+	.	.	+	.
Brachiaria mutica	.	+	.	.	4	.
Echinochloa colona	.	3	.	2	.	.
Dichrostachys cinerea	.	.	.	.	.	+
Acacia nubica	.	+	.	.	.	.
Clerodendrun hildebrandtii	.	.	.	.	2	.
Balanites aegyptiaca	.	.	.	.	.	+
Ficus somalensis	.	+	.	.	.	.
Psidium guajava	.	+	.	.	.	.
Calotropis procera	.	.	.	+	.	.
Maerua thomsonii	.	.	.	.	+	.
Cordia sinensis	.	.	.	.	+	.
Acacia nilotica	.	.	.	+	.	.
Solanum arundo	.	.	.	+	.	.
Neuracanthus sp.	.	1	.	.	.	.
Crotalaria comanesciana	.	.	.	.	+	.
Sarcostemma andongense	1	.	.	.	.	.
Priva cordifoiia	.	.	.	.	+	.
Oldenlandia fastigiata	.	.	.	.	+	.
Sesamum indicum	.	.	.	.	.	+
Hewittia subiobata	.	.	.	.	.	+
Corchorus triocularis	.	.	.	.	.	.
Clitoria ternatea	.	.	.	.	.	1
Tephrosia pentaphylla	.	.	.	.	.	+
Tragia hildebranatii	.	.	.	1	.	.
Erlangea somalensis	.	.	.	.	+	.
Phylla nodiflora	.	+	.	.	.	.
Typha domingensis	.	+	.	.	.	.
Echinochloa crus-pavonis	.	.	2	.	.	.
Brachiaria eruciformis	.	.	.	.	.	1
Cenchrus ciliaris	.	.	.	2	.	.

Cattle and sometimes sheep heavily graze in this area, with grazing percentages exceeding 70–90%. The vegetation is generally overgrazed. The degree of degradation is correlated with the different animal species who graze these areas: in fact, while camels are more adapted to the Somali environments, as they need water only once every two weeks or more and are not very selective in grazing and browsing, sheep, and in a larger extent cattle, need more frequent drinking, so they cannot move very far from villages or cultivated areas; moreover, they have a very selective grazing behaviour, discarding non-palatable plants that therefore tend to increase in the rangeland.

4.2.4. Agriculture land area *(Psoralea corylifolia* and *Heliotropium steudneri* community)

The vegetation of the agricultural area is commonly seen near the Shabelle river and channels, dominated by weed species, which reach the maximum cover when they grow in fallow areas with absence of wild trees and woody shrubs. The percentage of dwarf shrubs and forbs is about 53%, while grasses and sedges are more than 27% (Table 5).

The average total cover is very high, between 80 to 100%, comparing to rangeland vegetation ,

Human activity: the area is intensively cultivated with both tree crops (banana, mangos, coconuts, citrus etc.) and the herbaceous crops, mainly cereals (maize, sorghum, rice etc.). Other herbaceous crops are sesame, peanuts, beans etc.

Cattle grazing is common, but camels do not graze in the agriculture zones because of the presence of Trypanosomiasis during the wet season, to which the local breed of cattle is more adapted. The grazing intensity is low, about 5–10%.

4.2.5. Riparian forest *(Ficus sycomorus, Mimosops degan* and *Acacia stenocarpa* community mapped by De Marco and Fagotto (1978)

One of the rare fragments of forest vegetation still remaining along the Shabelle river in Southern Somalia. The forest has been destroyed for cultivation purposes. The tree species are now rare and still in danger for substitution with cultivation. No grazing takes place in this forest.

4.3. Dynamism

Vegetal stands are dynamic both in time and space. Besides the natural vegetation changes, the Somali vegetation dynamics are accelerated by external factors, particularly anthropic influence; rangeland vegetation dynamics follow different paths, depending on the human activities.

The Southern Somali rangeland is in its climax when the natural vegetation is dominated by trees and woody shrubs, characterised by the *Combretum hereroense* and *Grewia tenax* community, usually accompanied by *Dichrostachys cinerea, Dobera glabra, Boscia flavescens, Cordia sinensis, Salvadora persica, Grewia villosa, Commiphora sp., Sporobolus helvolus* etc.

After extensive browsing of camels and wild animals followed by collection of fuelwood, charcoal and construction material, the vegetation progressively changes into moderately degraded open bushland, characterised by the *Acacia zanzibarica* community. This vegetation is dominated by species like *Salvadora persica, Cordia sinensis, Grewia villosa, Dactyloctenium scindicum, Justicia bravensis, Indigofera sp., Alternanthera sessilis* etc.

The *Acacia zanzibarica* community, with overgrazing by goats, camels, sheep and cattle and with intensive woody biomass collection for energy, changes into the third phase of heavily degraded vegetation of the *Acacia nubica* and *Pupalia lappacea* community.

The dominating species are: *Ocimum sp., Indigofera sp., Pavonia eleganstn, Abutilon benadirensis, Acalypha volkensii* etc.

Usually the plants surviving in these conditions are not suitable for fuelwood, charcoal and construction materials, and are not palatable for animals.

Finally, overgrazing of cattle and sheep generates a land without vegetation, locally called 'Galgalimo' (which means 'bare ground').

Sometimes dense and open bushland are cleared by man for crop purposes. The farmers are destroying the natural riparian forest, for agricultural purposes. After some years of cropping, the peasants stop cultivating. The fallowed area will be colonised by annual and perennial weed species of the

Table 6. Number of animals in 100 ha per year.

	Potential grazing capacity				Actual stocking rate			
	Camel	Cattle	Sheep	Goat	Camel	Cattle	Sheep	Goat
Dense bushland	8	4.6	19.8	34	8	4.6	19.8	34
Open bushland	5	3	13	22	8	4.6	19.5	34.7
Degraded bushland	2.5	3	12	15	5	*6*	21	32
Agricultural zone	0.6	19	41	30	0.5	17	36	26

Psoralea corylifolia and *Heliotropium steudneri* community. Then theoretically after some years, if not cultivated again, (but this never happens in the study area) the *Ficus sycomorus, Mimosops degan* and *Acacia stenocarpa* community (riparian forest) should start to regenerate. This can be seen, sometimes, where agriculture areas have been fenced for long time by governmental agencies for ecological protection purposes.

4.4. Forage production and grazing capacity

A linear relationship has been shown between annual rainfall and annual forage production in the arid and semi-arid rangelands (Le Houérou and Hoste 1977; Penning de Vries 1983; Olang 1984). According to the National Range Agency (1985) estimations of the annual rangeland productions of Somalia, the most favoured southern rangelands can provide from about 313.0 kg/ha of dry matter with 201–400 mm up to 1338.5 kg/ha with more than 400 mm of rainfall per year. The study area receives more than 600 mm per year and produces about 900.0 kg/ha of dry matter in the browse layer and 450 kg/ha in the herbaceous layer. In the study area 67 plant species were utilized by the different animal types; 44 of them were herbaceous species, including graminaceae, grazed mostly by cattle, sheep or goats; the other 23 species were tree and shrub layer browsed by camel and wildlife.

The quality of fodder produced in the different vegetation types has been investigated. The species from different families which grazed by the herbivores were divided into different groups (legumes, grasses and sedges) and their pabular characteristic have been studied. Also species from other families and woody plants which are browsed during the dry season were considered.

The pabular value was estimated on the basis of the determination of protein and nitrogen content, and percentages of fiber, ash, and other components. The corresponding value of available energy (metabolizable energy, expressed in joule) was calculated using the standards of the Institut Nationale de la Recherche Agricole (1978).

These results were used for the estimation of grazing capacity and a index of overgrazing based on original procedures was calculated; this matter will be exposed in detail in a paper in press (Barkhadle and Ongaro 1993). As a final result the optimal surface required for one individual of the species of herbivores was estimated. The differences among the vegetation types here described are very impressive.

On the basis of data in Table 6 it is possible to demonstrate that a large portion of the study area is in condition of heavy overgrazing. Assuming 1 as the optimal quantity of herbivores in a given vegetation, this value increases to about 1.5 in the open bushland and to more than 2 in the degraded bushland.

This means that in this vegetation the number of grazing animals is twice that of the potential grazing capacity.

Conclusions

The lower Shabelle region in Somalia is a particular landscape developing along an ecological gradient from the moist ground along the river to the open *Acacia* woodland growing in semi-arid conditions. Human activity, based on pastoralism and (only in

the most favourable places) agriculture conserved this landscape for millennia. In the present condition, as a consequence of rapid population growth and of the presence of a consistent number of refugees, the landscape is submitted to heavy impact caused by overgrazing and intensive collection of fuelwood for energy. This has caused a general degradation of the plant cover.

Under the condition of traditional land use, in this country the vegetation was determining the types of human activities (pastoralism and agriculture); presently the situation is reversed and the consequences of human activities (overgrazing) are determining the types of vegetation and the general features of the landscape.

References

Barkhadle, A.M.I. 1992. Studio del pascolo e cartografia della vegetazione dei Distretti di Marka e Qoryooley, Somalia meridionale. Tesi di Dottorato di ricerca, Universita di Pavia, Italia.

Barkhadle, A.M.I. 1993. The Somali traditinal 'Deegaan' Ecological zone classification map and plant names. Riv. Agric. Subtrop. e Trop., in press.

Barkhadle, A.M.I. and Ongaro, L. 1993. A Technique for stocking rate assisment in arid and semi-arid rangelands: A case study in Southern Somalia. Riv. Agric. Subtrop. e Trop., in press.

Ciferri, R. 1939. Le associazioni del litorale marino della Somalia meridionale. Riv. Biol. Colon. 21: 5–42.

Cofodontis, G. 1953–72. Enumeratio plantarum Aethiopiae. Spermatophyta. Bull. Jard. Bot. Nat. Belg. suppl. 23–42.

De Marco, G. and Fagotto, **F.** 1978. Geobotanical and Ecofaunistic map of the lower Scebeli River Somalia. Centro di cartografia ecologica della Universita' di Roma.

F.A.O. 1986. The land resource base. African agriculture the next 25 years. FAO, Rome, Italy.

Friis, I. and Vollesen, K. 1989. Notes on the vegetation of Southernmost Somalia, with some additions to the flora. Willdenowia, 18: 455–477.

Knapp, R. 1973. Die vegetation von Africa. Ficher, Stuttgart, 626 pp.

Kuchar, P. 1989. The plants of Somalia: an overview and checklist. CRDP technical report LBii-CRDP-USAID. Louis Berger International Ltd., and Central Rangeland Project, Mogadishu, Somalia, pp. 339.

Jarrige, R. *et al.* 1978. Alimentation des ruminants. INRA, Versailles.

Le Houerou, H.N. and Hoste, C. 1977. Rangeland production and annual rainfall in the Mediterranean basin and in the African Sahelosudanian zone. J. of Range Mngt., 30, 3, 181–189.

Moggi, G. 1987. Researches on the coast of Somalia. The shore and the dune of Sar Uanle. Italian Journal of Zoology, n.s. supplemento XXII, n° 17: 291–330.

Muller Domhois, D. and Ellenberg, **H.** 1974. Aims and methods of vegetation ecology. Wiley, New York, 547 pp.

National Range Agency 1985. General Project Identification Mission. Notes on the livestock sector, Mogadishu, Somalia.

Olanga, M.O. 1984. Vegetation cover assessment in Turkana District, Kenya. *In* Proceedings of the International Workshop on land evaluation for extensive grazing. Leeg, Addis Ababa, Ethiopia, October 31–November 4, 1983.

Penning de Vries, F.W.T. 1983. The productivity of Sahelian rangelands: A summary report. Pastoral Network Paper 15b London: Agricultural Administration Unit Overseas Development Institute.

Pichi-Sermolli, R.E.G. 1957. Una carta geobotanica dell'Africa Orientale Eritrea, Etiopia, Somalia. Webbia 8, 129 pp.

Pignatti, S. and Warfa, A.M. 1983. The boscaglia vegetation complex in Southern Somalia. Tuxenia, n° 3: 159–168.

Raimondo, F.M. and Warfa, A.M. 1980. Preliminary phytosociological research on synantropical vegetation in Southern Somalia. Not. fitosoc., 15: 189–206.

Werger, M.J.A. 1974. On concepts and techniques applied in the Zurich-Montpellier method of vegetation survey. Bothalia 11: 309–323.

White, F. 1983. The vegetation of Africa. A descriptive memoir to accompany the UNESCO\AETFAT\UNESCO vegetation map of Africa. Unesco natural resources research n°20, pp. 356.

Wieland, R.J. and Werger, M.J.A. 1985. Land types and vegetation in the Luuq district of South-Western Somalia. Journal of Tropical Ecology, 1: 65–87.

Wildi, **O.** and Orloci, **L.** 1989. MULVA-4 a package for multivariate analysis of vegetation data. Swiss Federal Institute of Forestry Research, Birmensdorf.