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Honor — Fraternity — Justice

Ministry of Economy and Finance

Directorate of Studies and Programming

RAMS PROJECT

Rural Assessment and Manpower Surveys

Environmental Regeneration of
Southern Third of Mauritania

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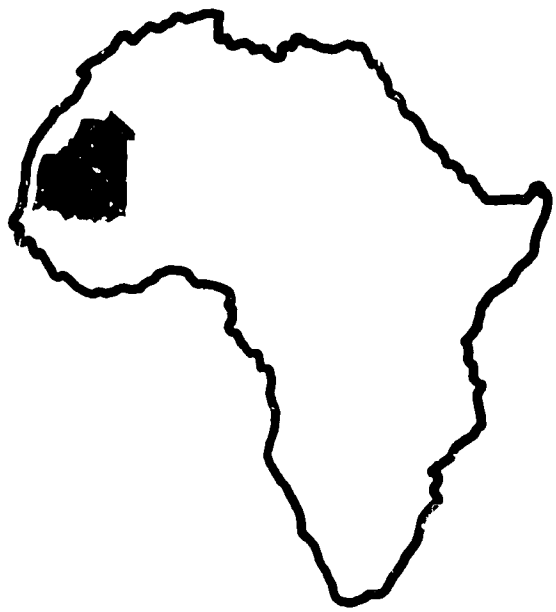

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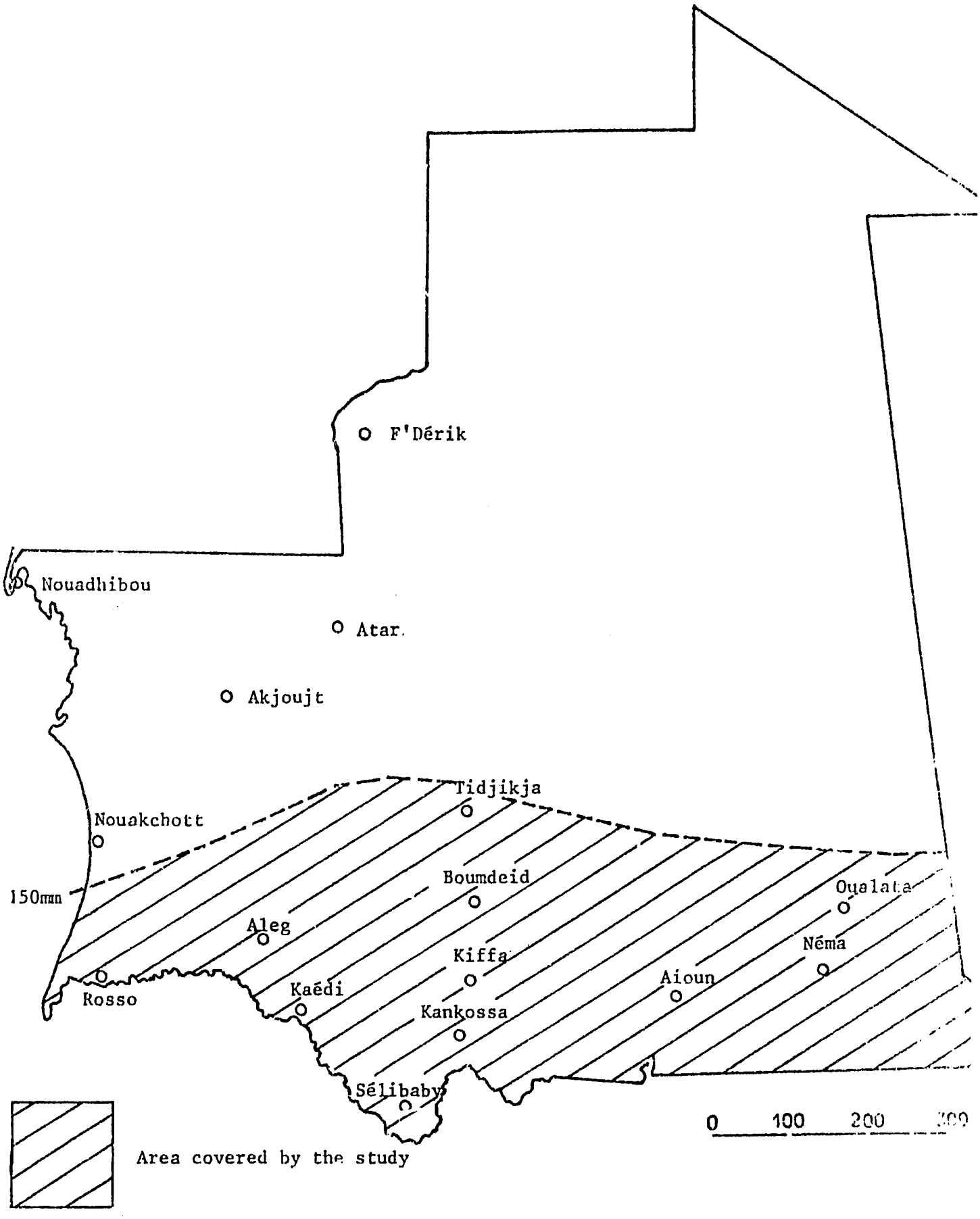
LIST OF VERNACULAR NAMES OF WOODY SPECIES.

Latin Name	Hassaniya Name	Poular Name
Capparis decidua	iguinine	goumi-danévi
Acacia sénégal	irwar	datouki
Acacia raddiana	talha	tielouki
Balanites aegyptiaca	teïchott	mourtoki
Maerua crassifolia	atil	sogui
Commiphora africana	adress	badi
Acacia flava	tamat	boulbi
Acacia nilotica	amour	gaoudi
Bauhinia rufescens	ndern	namadi
Zizyphus mauritiana	sder lahbil	diabi
Tamarix aphylla	tarfa	
Acacia albida	avrar	cade
Acacia seyal	sedra el beyda	allouki
Prosopis sp.		koki
Euphorbia balsamifera	ifernan	badakarey
Salvadora persica	aferchi	boudi
Boscia sénégalensis	eyzen	guiguilé
Adansonia digitata	teydoum	boki
Calothropis procera	tourja	bamévani
Combretum glutinosum	tikifit	diki
Bauhinia reticulata	tenzekré	barhévi
Hyphaene thécaïca	zguilem	gori
Sterculia sétigéra	demboya	boboli
Sclerocarya birréa	dembou	héri
Sterculia tomentosa		
Ptérocarpus erinaceus	yatta	bani
Guiera sénégalensis	liyina	guelloki
Grewia bicolor	imijy	kelli
Adenium sp.	teydou-ed-dib	
Grewia tenax	legleya	
Mytragina inermis	aguelal	koïli
Dalbergia melanoxylon	sangou	diallambané
Combretum aculeatum	ikik	
Salix sénégalensis	hole safra	kéli
Cadaba farinosa	azrom	sinsini
Borassus flabellifer	nkhal	adoubé
Gymnesporia sénégalensis	eych	
Ptérocarpus luscens	labara	tchiabi
Tamarindus indica	aganat	diami
Indigofera sp.	gara	gara

The Southern Third of Mauritania



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0- INTRODUCTION: Objectives of this study

The exceptional gravity of the drought and its harmful effects on the nation's economy (and consequently, on the well-being and future of the Mauritanian people) are a major concern of the Mauritanian government. The extent of this concern was expressed during a national seminar on the combat against desertification [1/] (Nouakchott, May 26-28, 1980). Near the end of this seminar, it was recommended that a national committee to combat desertification be formed, under the direct authority of the head of State.

The objective of the present study of Regeneration of the Environment of the Southern Third of Mauritania is to contribute to the fight against desertification by increasing knowledge of local conditions through field study and by analyzing the concrete problems experienced by the local populations confronted on a daily basis with a steadily deteriorating environment.

The general context of this study is determined by the drought which has stricken this country for nearly 12 years.

This study concerns only the southern third of the nation. It covers approximately the area south of the 150 mm isohyetal line (1941-1970 average), where are concentrated most of the agricultural and pastoral of its population

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1/ Presided by the Ministry of Rural Development

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Field analysis of the current situation of the Mauritanian environment was conducted with the main objective of increasing knowledge of regional conditions, in order to formulate realistic solutions, adapted to local requirements, for the protection and regeneration of the environment.

During the study, it has become apparent that the actions of man and animals have been of great consequence in the process of environmental degradation.

During numerous field surveys, it was seen that the southern third of Mauritania was not homogeneously affected by degradation and that variations occured as a function of physical and human factors, as well as of latitude.

The study of the "Major Agro-Ecological Zones of Mauritania" has already examined, in a general manner for the entire country, the existing regional differences for the use of space as a function of physical and human criteria (with insistence on the severity of the drought and its consequences).

This more detailed study will analytically examine the villages and towns, pastoral wells, pastures, classified forests and some oasis of the specific agro-ecological zones.

It is intended to serve as a basis for future concrete actions to improve the quality of life of the population of the agro-ecological zones in the southern third of Mauritania.

1. SPATIAL LIMITS OF THE STUDY ZONE

As explained in the introduction, this study covers approximately the southern third of the country, where about 80% of the Mauritanian population lives (unequally distributed).

The 150 mm isohyetal line was selected as the northernmost limit for the study zone for the following reasons (see Figure 1):

- The zone thus defined covers the main areas of Mauritanian cultivation, livestock raising and forests.
- This vast zone is susceptible to the most degradation; in addition to climatic uncertainties, the over-exploitation of vegetable resources by population and livestock are harmful to the environment.
- The density of humans and animals is much higher south of the 150 mm isohyetal line than in the northern part of the country which is essentially covered by the Sahara desert. The south-western portion of the southern third of Mauritania bordering the Senegal River and the Guidimaka are the most populated sectors of the study zone.
- The southern part of the country, located south of the 150 mm isohyetal line, corresponds approximately to 1/3rd of Mauritania's surface area.

1.1. ADMINISTRATIVE REGIONS COVERED BY THE STUDY (See Fig. 2 and 5 in Annex I)

Eight administrative regions are totally or partially covered by the study zone.

Region 6 : Trarza, southern part

Region 5 : Brakna

Region 4 : Gorgol

Region 10: Guidimaka

Region 9 : Tagant, southern part

Region 3 : Assaba

Region 2 : Hodh El Gharbi

Region 1 : Hodh El Charqui, southern part

Below are given the distribution of the surface areas of the administrative regions covered by the study (source: BCRP, IRM, 1977).

Administrative Regions	Total Surface area/region	Surface area concerned by this study	Percent
Region 6	67,800 km^2	33,900 km^2	± 50%
Region 5	33,000 "	33,900 "	100%
Region 4	13,600 "	13,600 "	100%
Region 10	10,300 "	10,300 "	100%
Region 9	95,200 "	47,600 "	± 50%
Region 3	36,600 "	36,600 "	100%
Region 2	53,400 "	53,400 "	100%
Region 1	182,700 "	91,350 "	± 50%

The southern third of the country, south of the 150 mm isohyetal line, covers a surface area of approximately 319,750 km^2, or about 30% of the total surface area of Mauritania (1,030,000 km^2).

2. METHODOLOGY AND MEANS EMPLOYED

The basic objective of this study is to formulate concrete proposals for the protection and regeneration of the Mauritanian environment.

In order to do so, it was necessary to conduct a "diagnosis" in the field of the present situation and the evolution of the environmental degradation process due to human and animal activities and the continuing drought.

Given the large size of the southern third of Mauritania (about 320,000 km^2) and the impossibility of exhaustive coverage of the entire study zone, certain observation sites were selected in the field.

These observation sites are located:

- around towns and villages
- near pastoral wells
- in different pasture lands (ranges)
- in classified forests
- in some palm groves

They have been selected as representative of the conditions of the Mauritanian environment.

The following gives a more detailed explanation of the use of the different observation sites and the methodology of the study.

2.1. TOWNS AND VILLAGES

The study of the environment around towns and villages is very important, as the majority of the Mauritanian population has become

sedentary and the process of rural exodus has increased with the persistant drought (which was worst in 1972-73).

Exploitation of the environment around towns and villages has increased in an uncontrolled manner, at the same time that the needs of the population have increased:

- intensive cutting of wood for fire wood, wood charcoal (usually for export to large urban centers), housing, etc.
- increased clearing for cultivation and decrease in fallow land, over-exploitation of lands already improved.
- a net increase of sedentary livestock (mainly goats and sheep). causing intense over-grazing around towns and villages

All these factors cause degradation zones around villages and towns, of which the extent varies according to the size of the sedentary populations and their activities.

In some areas, shifting dunes and sand covers can be seen to invade and progessively destroy housing (as at Charat, near Mederda in the Trarza) covering road links (example: Nouakchott Kiffa road), destroying crops (Guidimaka basins), oueds and wells. The destruction of the vegetable cover by men and animals maintains and exaccerbates the desertification phenomenon, particularly around sedentary areas.

METHODOLOGY

The selection of towns and villages as observation sites was based on the following criteria:

Table 1, taken from the Central Census Bureau of Mauritania, shows the growth rates of urban population from 1961-62 to 1977. This sedentarization in the already fragile Sahelian milieu has provoked increased environmental degradation.

Table 1: Population Growth in Urban Centers 1961-62 to 1977

Urban Center	Region Number	Population 1-1-1977	Population 1961-62	Date	Total Growth Rate	Average Annual Growth Rate
1.Nouakchott	district	143,980	5,807	1961	+2,324.5%	+ 22.5%
2.Nouadhibou	8	21,961	5,283	1961	+ 315.7%	+ 9.6%
3.Kaedi	4	20,848	9,167	1962	+ 126.7%	+ 5.8%
4.Zouérate	11	17,474	4,659	1962	+ 321.4%	+ 10.4%
5.Rosso	6	16,466	4,811	1961	+ 242.3%	+ 8.3%
6.Atar	7	16,326	9,528	1962	+ 71.3%	+ 3.8%
7.Kiffa	3	10,629	4,359	1962	+ 143.8%	+ 6.3%
8.Aïoun	2	8,775	4,877	1962	+ 79.9%	+ 4.1%
9 Nema	1	8,232	3,893	1962	+ 111.5%	+ [illegible].3%
10.Boghé	2	8,056	5,867	1961	+ 37.3%	+ 2.1%
11.Akjoujt	12	8,044	2,518	1962	+ 219.5%	+ 8.3%
12.Tidjikja	9	7,870	3,661	1962	+ 115.0%	+ 5.4%
13.Boutilimit	6	7,261	2,774	1962	+ 161.8%	+ 6.9%
14.Aleg	5	6,415	1,360	1962	+ 371.7%	+ 11.3%
15.Sélibaly	10	5,994	2,737	1962	+ 119.0%	+ 5.6%
16.Timbedra	1	5.317	1,815	1962	+ 192.9%	+ 7.7%

Source: Central Bureau of Population Census, Situation as of Jan. 1, 1977. Ministère du Plan et des Mines, I.R.M.

Whenever possible, a town of at least 1000 inhabitants was selected in order to study the population's impact on the environment. These towns correspond to sedentarization areas representative of man's pressure on the milieu, and thus of the typical problems confronting the population due to a degrading environment.

- the regional centers and largest urban centers were systematically visited, as their impact on the environment is far from negligeable due to the size of their populations and their role as centers of attraction for those fleeing the drought.

- towns and villages were also selected by agro-ecological zone in order to study specific environmental problems identified in a preceeding study 2/.

- the most representative geomorphological units were also included in the selection of locations, as they may influence the type of degradation (for the same cause, effects may vary according to geomorphological units: dunes, rags, alluvial valleys, sand-stone plateaus,etc.).

- the limits of administrative regions, of course, had no effect on the choice of observation sites, as they are rarely related to physical criteria. However, mention of region limits is made in maps and descriptions, to serve central and regional authorities in their planning for the future.

NOTE: In cases where there was no location having a population of more than 1000 that satisfied the other criteria, smaller villages were selected.

2/ "Major Agro-Ecological Zones of Mauritania", RAMS, Base Line Report, Feb. 20, 1980

For the total of 40 towns or villages selected [3/], a questionnaire on the environment was established (57 questions),[4/] concerning the following major themes:

I - Water

II - Physical Constraints

III - Livestock

IV - Animals and pasturage

V - Wood exploitation

VI - Vegetation and the drought

VII - Crops

VIII - Towns, villages and population

Without being exhaustive, this questionnaire furnishes useful information about the factors contributing to environmental degradation around towns and villages, in the context of the major agro-ecological zones and major physical units of the southern third of Mauritania. This information will be useful in finding solutions to restore the environment in the future.

To supplement the information concerning vegetation obtained from the questionnaire, vegetation transects [5/] were performed systematically around the 40 towns and villages.

3/ See list of towns and villages studied in Chapter 3

4/ See Questionnaire in Annex

5/ See transects in Annex II

These transects were conducted as follows:

- Starting from the town limits, 2 directions were selected and followed for a distance of 3 miles (measured using a LandRover milage meter)

The directions of the transects were chosen as a function of physical and vegetation units which appear to be the most representative. At times, the topography of the terrain left little choice as to the directions to be taken. A compass was used to determine directions.

The transects permitted direct study of the following factors concerning ligneous vegetation:

- dominant species and proportion (%)
- secondary species and proportion (%)
- height of species (meters)
- average spacing between species (meters)
- condition of vegetation: drying, dead trees, dead branches, over-grazing, cutting, etc.

  for herbaceous vegetation, the observation period (May, June, July) was not favorable, as most of the herbaceous cover was absent or reduced to dried straw which was difficult to identify. The rate of coverage (%) was identified.
- the topography, mineral nature of soil surface and general condition of pasturage are furnished on the transect summary sheets.

2.1.1. Aerial Photographs cf. Figures 11 through 14,

Comparison of aerial photographs from 1952-54 with recent photographs of 1980 permitted determination and mapping of the extent of environmental degradation phenomena around a certain number of towns. This work was performed for the following towns:

Mederdra

Boutilimit

Aleg

Sélibaly

Scale was 1/50,000.

2.2. Pastoral Wells (cf. Figures 4 through 6,

Observation of vegetation and conditions of surface soil around a certain number of pastoral wells helped to evaluate the impact of livestock concentrations on the surrounding pastoral environment.

As Mauritania is, above all, a livestock-raising nation, this subject must be studied by precise observations in the field.

Six pastoral wells were studied, of which 4 are in the Trarza 6/, the region which has the highest concentration of wells in Mauritania and is the most representative of animal concentrations in a dune environment.

- One well was selected to the southeast of Kankossa
- Also selected was a concentration of oglats in the Aftout, to the west of the Assaba Massive.

6/ See Chapter 3 for study of pastoral wells

With the exception of the traditional oglats in the Aftout, all these wells are cemented (and thus "datable"). Most of them are relatively old, dating from before Independance.

Vegetation transects were conducted for each well, using the same methods as those employed for towns and villages (for a distance of 2 miles).

2.3. "PASTURAGE" cf. Figures 4, 5 and 6 in Annex

These "pastures" are essentially trees, as the herbaceous cover was absent during the observations. These "pastures" serve as pastoral ranges and are composed of natural vegetation.

19 pastures were selected[7/], generally located at a good distance away from towns and villages and water holes, in order to evaluate the condition of the environment under minimal pressure from men and animals. The zones which undergo little or no human or animal impact are interesting, as they permit evaluation of natural regeneration in an environment protected from intensive cutting, over-grazing, trampling and other degradation.

- For each pasture, a vegetation transect was conducted, using the same method as for towns and villages and pastoral wells.[8/]

7/ See chapter 3 for study of pastures

8/ See Annex II for Transect Sheets.

The pastures studied were distributed over different types of soils linked to the different major physical units representative of environmental conditions.

2.4. CLASSIFIED FORESTS cf. figures 20 through 23, Annex

Mauritania's classified forests have been decimated by the lack of rainfall and by man, who is often unconcerned by the necessity to preserve the national forest heritage.[9/] These forests are "classified" in name only. This study permitted evaluation of what is left of the classified forests in 1980 (these forests were classified well before Independence) and to study the appropriate measures for their rehabilitation.

Most observations were conducted along the Senegal River, where the classified forests of Gonakié (*Acacia nilotica*) are of undeniable economic importance, as they furnish the wood charcoal produced and shipped throughout the entire country.

The other classified forests are located in sandy milieus (diéri) far from the river, and are mainly composed of gum trees (*Acacia senegal*), which were formerly of economic importance for the production and marketing of gum arabic, a trade which is now insignificant.

Note: Some of the gum trees groves were not part of classified forests

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9/ See Chapter 3 for study of condition of classified forests

Transects (using the above cited methods) were conducted through 17 classified forests, of which 10 were Gonakié forests on Oualo lands along the Senegal River.

2.5. Palm Groves (cf. fig. 19

A number of palm groves (17 in total) located in Tagant and Assaba was studied in the context of a joint mission undertaken with the RAMS expert concerned with the Oasis subsector (cf. chapter 3.8), in order to gain an impression of their environment.

2.6. Number of Days of Field Observation

Numerous field trips were conducted, totally 62 days of study in the field. The following table gives the chronology and sites of field observations (see maps of field itineraries in Annex I).

Number of Days Field Trip	Dates (1980)	Location of Field Trips
10 days	April 23 - May 2	Tagant - Assaba (oasis)
3 days	May 15 - 17	Trarza
2 days	May 22 - 23	Trarza
7 days	May 29 - June 4	Senegal River/Classified Forests
13 days	June 11 - 23	Corgol, Brakna, Guidimaka
14 days	June 11 - 24	Tagant, Assaba
13 days	July 29 - 21	Hodh El Gharbi - Hodh El Chargui
		(8 Administrative Regions)
Total: 62 dyas		Total: ± 9,600 kilometers

In addition, a three-day mission to the National Geographic Institute and Teledyne Geotronics in Dakar was made in order to work on recent aerial photographs from the OMVS project (see chapter 2.1.1).

3. CONDITION OF THE MAURITANIAN ENVIRONMENT, MAIN CAUSES OF DEGRADATION AND PRESENT TRENDS

The observation sites permitted identification for specific regions of the mechanisms of degradation and their basic causes, as well as the current trends towards improvement, stagnation or worsening of phenomena.

The results of field work will first be examined analytically for towns and villages, pastoral wells, pastures and classified forests. In a second phase, an overall evaluation of the state of the environment will be given.

3.1. DESERTIFICATION

Desertification is steadily increasing in Mauritania, as well as in most other Sahelian countries. Desertification has been defined as the "decrease or destruction of the biological potential of the land, and is one of the aspects of generalized degradation of the ecosystems of arid and semi-arid zones which have been perturbed by increased exploitation of the biological potential in order to satisfy the needs of growing populations aspiring to development" (United Nations Conference on Desertification, Plan to Combat Desertification, Aug. - Sept., 1977).

Mauritania is especially exposed to the desertification process, due to the insufficient eco-climatic conditions and irregular rainfall, the abundant sunshine, the light and sandy soils, and frequent winds.[10/]

10/ Many of these remarks on desertification are based on "Document Préparatoire, Rapport général, Séminaire National pour la lutte contre la désertification en R.I.M.", 1980.

This process has been accelerated in an alarming manner during the past 12 years due to the persistant drought which has be fallen the entir Sahel region and in particular, the northern fringe of the Sahel in Mauritania.

In order to illustrate the effects of the drought on the desertification process, the following examples may be cited:

- of the total 1,030,000 km2 of national territory, 14 million of the 15 million hectares which were not desertified have been affected over the past 20 years.

- the Acacia senegalensis (gum tree) populations of certain areas disappearing (notably in the Trarza)

- 43% of the surface area of classified forests (mainly Acacia nilotica) in the Senegal River valley were destroyed between 1972 and 1977 11/

- the surface areas cultivated in cereals decreased from 272,000 hectares in 1969-71 to 187,000 hectares in 1972-74, and cereal production went from 93,000 to 41,000 tons over this same period.

- during recent years, grass covers have totally disappeared in many areas (notably in the regions of Boghé, R'Kiz, Tamchakett, Kiffa, M'Bout) 12/

11/ OMVS Study

12/ FAO Mission, January 1980.

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These examples show that the desert, which occupies most of the nation's surface area, menaces extension into the south, invading the Sahelian zone inhabited by nearly 80% of the Mauritanian population.

Almost all the classic causes of desertification can be found in Mauritania; eco-climatic causes which are particularly favorable to the extension of the desertification process are further execcerbated by socio-economic causes.

The Mauritanian climate is characterized by sparse and irregular rainfall; average annual rainfall is less than 200 mm for most of the country (see isohyetal map for 1941-1970). The climate is also characterized by winds (alizé, harmattan and monson) caused by the Azores and St. Helene anticyclone movements.

Most of the nation experiences a Saharan climate where annual rainfall does not exceed an average of 150 mm. The occurrence of long periods of drought is another characteristic of the Mauritanian climate. Since 1968, the country has suffered 12 years of drought, either generalized or localized. These drought cycles profoundly affect the equilibrium of the particularly fragile eco-systems, the alteration of which has harmful ecological and socio-economic consequences.

Ecologically, there has been rapid degradation of natural resources due to increased human and animal pressure and the use of inappropriate exploitation techniques.

The long term consequences of exploiting marginal soils, particularly susceptible to erosion, has been ignored due to the need to satisfy demand for cereal products and the race to appropriate lands. The limited means of the Ministry of Rural Development services do not permit the education of the population as to the effects of irrational land use nor the instruction of other techniques better suited to prevention of degradation of the soil's biological potential.

The disorganized exploitation by herdsmen of the pasture lands, of which the potential has been greatly decreased by the drought, has also exacerbated desertification, especially around water holes or sedentarization zones where herds are concentrated.

The result is the disappearance of vegetable cover, denuding the superficial soil layers, which thus become more vulnerable to wind and water erosion. Following the degradation of vegetation cover, sand winds have increased, constituting a grave menace to the socio-economic infrastructures and the production potential of the nation.

Intensive exploitation of woody species for fuel and wood has furthered the degradation process.

Thus, it is clear that the combined effects of human activities and persistant rainfall deficits have increased desertification phenomena in Mauritania. The socio-economic consequences are considerable: increased food deficits, increased poverty of rural populations, acceleration of rural exodus, anarchic development of some urban zones; these are all indexes of the profound perturbation of traditional structures.

Two studies carried out by the Sociology Unit of the RAMS project 13/ highlight the difficulties of people in adapting to new conditions created by the present drought, compared to conditions of preceding droughts: this new situation results not only from climatological and demographic causes, but also from profound social and economic disturbances that have shaken traditional society.

13/ Les Maures, by Abdel Wedoud ould Cheikh (1980) and Mouvements de population et migrations en Mauritanie, by Pierre Bonte (1980).

The following sketch (Sketch 1) concerns the Trarza dune zone. It examines the complex process leading to desertification and underline the major role played by man and livestock in the mechanisms of environmental degradation. It is a theoretical approach to the desertification phenomena in a Sahelian dune milieu.

3.2. MAJOR PHYSICAL UNITS AND THE AGRO-ECOLOGICAL ZONES CONCERNED

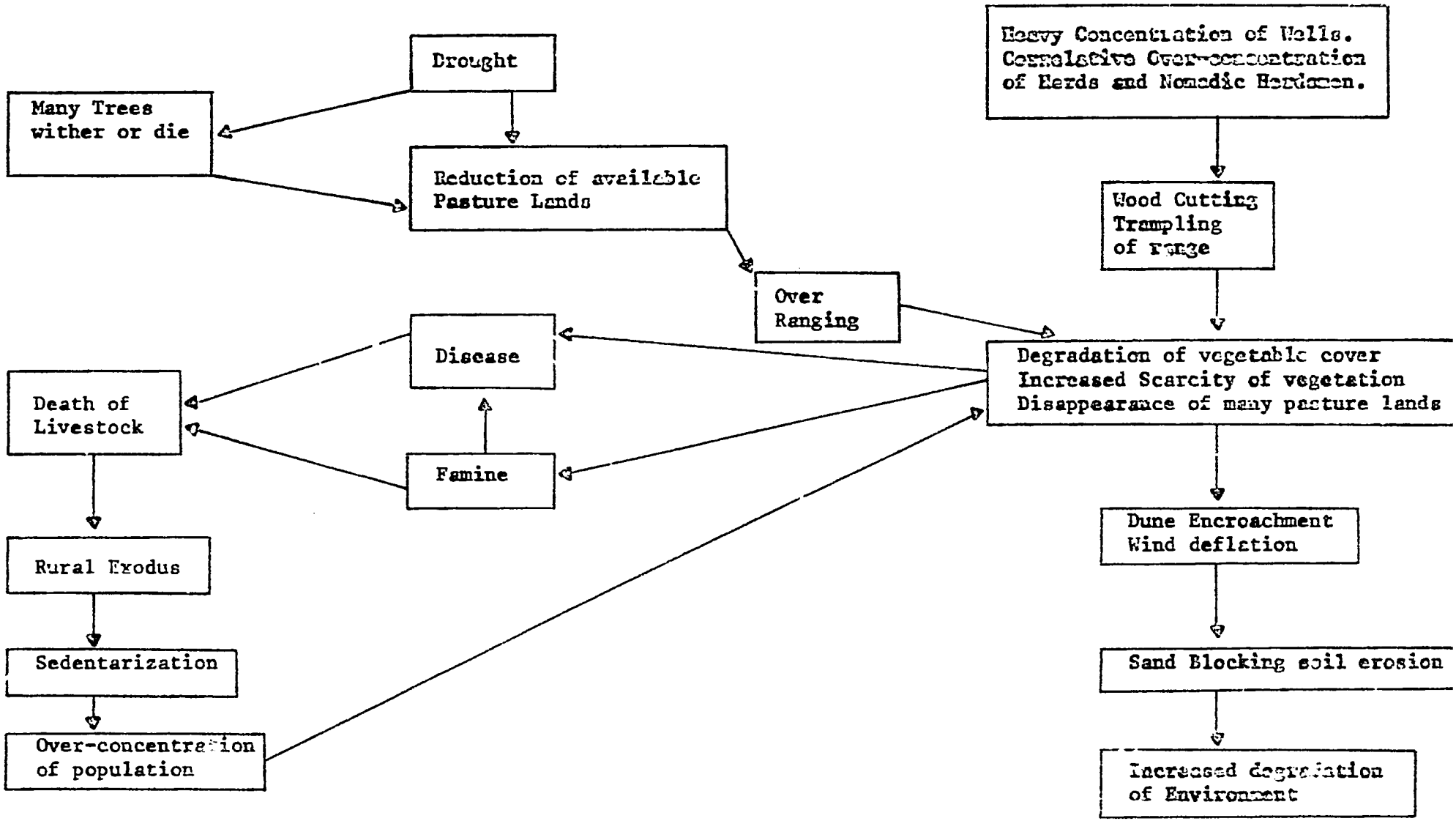
(See figures 3 and 6)

The preceding study of "Major Agro-Ecological Zones of Mauritania"[14/] has already described the major physical and geomorphological characteristics of Mauritania and the distribution of agricultural activities as a function of environmental constraints. Major agro-ecological zones were also identified.

Figures 1 and 2 show the physical regions of the southern third of Mauritania and the location of the different observation sites of this study. Figures 5 and 6 locate these observation sites in the major agro-ecological zones.

The following tables show the overall distribution of observation sites in the physical units and agro-economic zones (see Tables 2 and 3).

14/ RAMS, Base Line Report, Feb. 20.



Sketch 1. Process of desertification in Sahelian pastoral dune zones.

Source: RAMS, 1980.

Table 2

Geographical Units and Observation Sites

Geomorphological Units	Towns and Villages	Pastoral Wells	Pasture Lands	Classified Forests
Trarza - Brakna dunes	7	4	5	5
Karakoro dunes	2	-	-	-
Sandy plain located between the Tagant and the Assaba massives to the West and the Affole massive in the east	2	-	1	1
Sandy Hodhs zone	2			
Aftout: Clayey-sandy gulleyed rag zone located to west of the Tagant and Assaba, extending to the gorgol and Brakna	7	1	1	
Alternating, clayey-stoney-sandy plains and Guidimaka inselbergs	1		3	
Clayey-sandy plain south of Hodhs	4		2	
-Sandstone Tagant massive	4		3	
-Sandstone Assaba massive			1	
-Sandstone Affolé massive and borders	3	1	2	1
-Dhar Néma Piedmont (alluvial sandstone)	2		1	
-Senegal River Valley	6		10	10
	40	6	19	17

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TABLE 3 - Number of Observation Sites
Per Agro-Ecological Zone

Major Agro-Ecological Zones (See Fig. 5 and 6	Towns Villages	Pastoral Wells	Pasture Lands	Classified Forests
A. Senegal River Valley	6			10
B. Rainfed cultivation Zone	9	2	6	
C. Floodland cultivation Zone	6		4	1
D. Oasis (palm-grove) Zone	4		1	
E. Pastoral Zone	10	4	6	5
Complex Zones				
B - C	2			
B - C - D	11			1
C - D	2		2	
Total Observation Sites (82)	40	6	19	17

3.3. LIST OF VEGETATION SPECIES ENCOUNTERED IN THE SOUTHERN THIRD: SPECIES - FREQUENCY - LOCATION

For the entire southern third of Mauritania, of a total of 32 observations, we observed 40 woody species and calculated their frequencies as compared to the total number of transects performed (111).

This information is given in Table 4, "List of Species Encountered for all 111 Transects and Frequency" and in Table 5, "Location of Woody Species Encountered".

In this study, the emphasis has been on the nature and condition of the vegetable cover, as this serves as an excellent index of the degree of environmental degradation. Natural vegetation plays an important role because it is related to:

- the feeding of grazing animals by providing pastures (herbaceous and aerial);
- the feeding of people during drought years or during the dry season (seed pods and fruit)
- providing firewood.

Destruction of vegetation may, on a more or less long-term basis, cause the disappearance of the nation's pedological patrimony and thus, agricultural and pastoral activities. Such deterioration would be disastrous for Mauritania.

TABLE 4: LIST OF SPECIES ENCOUNTERED FOR ALL 111 TRANSECTS AND FREQUENCY

SPECIES	NUMBEI OF OBSERVATION (OUT OF A TOTAL 608)	FREQUENCY %	SPECIES	NUMBER OBSERVATIONS (OUT OF A TOTAL 608)	FREQUENCY %
Capparis decidua	30	4.9	Bauhinia reticulata	8	1.3
Balanites aegyptiaca	92	15.1	Hyphaene thebaïca	5	0.8
Acacia senegal	56	9.5	Sterculia sétigera	2	0.3
Maerua crassifolia	31	5.09	Sclérocarya birréa	9	1.4
Commiphera africana	15	2.4	Sterculia tementosa	4	0.6
Acacia flava	35	5.7	Ptérocarpus erinaceus	1	0.1
Acacia nilotica	33	5.4	Guiéra senegalensis	4	0.6
Bauhinia rufenscens	27	4.4	Grewia bicolor	3	0.4
Ziziphus mauritania	36	5.9	Adénium sp.	2	0.3
Tamarix aphylla	4	0.6	Grewia tenax	1	0.1
Acacia seyal	27	4.4	Dalbergia melanoxylon	1	0.1
Acacia albida	7	1.1	Mytragina inermis	3	0.4
Prosopis sp.	2	0.3	Combretum aculeatum	3	0.4
Eupherbia balsamigera	11	1.8	Salix senegalensis	2	0.3
Salvadoria persica	6	0.9	Cadaba farinosa	1	0.1
Boscia senegalensis	23	3.7	Berassus flabellifer	2	0.3

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Adensonia digitata	15	2.4	gymnesporia senegalensis	1	0.1
Calothropis procera	25	4.1	Ptérocarpus luscens	1	0.1
Indigefera sp.	4	0.6	Tamarindus indica	2	0.3
Combretum glutinosum	22	3.6	Acacia raddiana	50	8.2

TABLE 5 - LOCATION OF WOODY SPECIES ENCOUNTERED
(SEE LOCATION MAPS IN ANNEX, FIGURES 1 AND 4)

SPECIES (40)	TOWN OR VILLAGE NUMBER	CLASSIFIED FOREST NUMBER	PASTURE NUMBER	PASTORAL WELL NUMBER
Capparia decidua	1-2-4-9-10-12-13-22-24-28-29-30-31	11-12-15-17	9-10-11-13-14-15	21
Acacia senegal	1-2-4-5-8-10-16-17-18-26-27-28-29-32-33-34-35-38-39-40	1-3-4-5-17	1-4-5-6-11-12-13-14-17-18-20-23-24	2-3-7-16-21-
Acacia raddiana	1-2-4-5-8-10-14-20-21-22-23-24-25-26-28-29-31-32-35-36-37-38-39	3-4-5-	4-5-9-10-12-13-14	2-3-7-8-16
Balanites aegyptiaca		1-2-3-4-5-9-10-11 13-15-16-17	4-5-6-9-10-11-12-13-14-15-17-18-22 23-24-25	2-3-7-8-16-21
Maerua crassifolia	1-2-8-10-11-20-22-23-24-25-31 32-36-37-38	3-4-	4-5-10-11-12-14-25	8
	1-11-27-31-32-35-38		9-12-13-20-25-	8
Acacia flava	4-11-12-14-15-20-22-25-28-29-30-31 32-34-36-37-38-39		10-13-14-15-20-23-25	21
Acacia nilotica	4-7-12-19-21-26-27 30-31-34-35-39-40	6-8-9-10-11-12-13-14-15-16-17	15-17	21

TABLE 5: (CONT.)

SPECIES (40)	TOWN OR VILLAGE NUMBER	CLASSIFIED FOREST NUMBER	PASTURE NUMBER	PASTORAL WELL NUMBER
Bauhinia rufescens	4-14-17-19-26-28-29-	1-12-13-15-16	4-15	21
Zyziphus mauritiana et sp.	4-12-14-17-22-25-26-27-28-29-30-31-32-34-39-40	1-4-13	5-10-12-15-20-25	21
Tamarix aphylla	6-7	2-19		
Acacia albida	6-7-33-40	1-2-13		
Acacia seyal	6-12-19-22-25-28-30-33-35-36-38-39	1-2-9-14-15	4-17-18-20-23-25-	3-21
Prosopis sp.	6	2		
Euphorbia balsamifera	7-22-23-24-32-37		11-12-13	
Salvadora persica	7-22	1-9-19	12-25	
Boscia senegalensis	9-10-11-13-14-17-22 23-24-27-31-32-37-38	11-12	11-12-13-25	21
Adansonia digitata	11-14-17-18-27-33		[illegible]-20-22	16

TABLE 5: (CONT.)

SPECIES (40)	TOWN OR VILLAGE NUMBER	CLASSIFIED FOREST NUMBER	PASTURE NUMBER	PASTORAL WELL NUMBER
Calothropis procéra	15-20-22-23-24-25-26 28-29-32-33-35-40	4-17	13-23	3-16-21
Combretum glutinosum	16-17-18-19-26-27-33-34-40	17	17-19-20-22-24	16
Bauhinia reticulata	17-19-27-28-29	12-16		
Hyphaene thébaïca	18-26-27			16
Sterculia sétigéra	18		20	
Sclérocarya birréa	27-34		17-19-22-24	16
Sterculia tomentosa	27		22-24	
Ptérocarpus eranicens	27			
Guiera sénégalensis	27-34			
Adenium sp.	27			

TABLE 5 - (CONT.)

SPECIES (40)	TOWN OR VILLAGE NUMBER	CLASSIFIED FOREST NUMBER	PASTURE NUMBER	PASTORAL WELL NUMBER
Grewia tenax	33			
Mytragina inermis	34			
Dalbergia mélanoxylon	34			21
Combretum aculéatum	37		24-25	
Salix sénégalensis		10-15		
Cadaba farinosa		10		
Borassus flabellifer		1-19		
Gymnesporia sénégalensis		1		
Ptérocarpus luscens	38			
Tamarindus indica				3-21
Indigefera sp.	15	1-13-14		

3.4. STUDY OF THE ENVIRONMENT AROUND TOWNS AND VILLAGES (see Figures 1 to 3 in Annex I)

Table 6 gives a list of 40 towns and villages, with their locations (latitude and longitude) and their populations as of 1/1/77[15/]

As indicated in Chapter 2, the study of the environment around towns and villages is particularly important due to the massive rural exodus and sedentarization provoked by the drought.

Figures 1, 2 and 3 (see Annex) show the towns and villages studied, classified in the following categories:

Figure 1 : Sites Observed and Physical Regions

Figure 2 : Sites Observed and Agro-Ecological Zones

Figure 3 : Sites Observed and Administrative Regions.

3.4.1. THE PHYSICAL MILIEU OF THE SOUTHERN THIRD OF MAURITANIA

The zone covered by this study includes 4 types of physical milieu (geomorphological units), all of which are largely represented and which are, by order of size :

a. dunes and sandy plains

b. rags and clayey -sandy plains

c. sandstone massives

d. Senegal River valley

15/ Figures from Mauritanian Central Census Bureau

Table 6

Towns/Villages - Latitude - Longitude - Population 1/1/1977

Region	Longitude	Latitude	Population
Trarza (06)			
1. Ouad Naga	15.27	17.56	830
2. Aïn Salama	14.41	17.37	1.192
3. Bareïna	15.12	17.09	1.128
4. R'Kiz	15.09	16.55	1.744
5. Mederdra	15.39	16.55	3.080
6. Rosso	15.48	16.31	6.178
7. Keur Macène	16.14	16.33	1.292
8. Tiguent	16.00	17.15	808
Brakna (05)			
9. Aleg	13.54	17.02	5.185
10. Bou ghbeira	13.54	17.25	376
11. Cheggar	13.39	17.19	1.884
12. Dionaba	12.35	17.06	957
13. Bababé	13.57	16.20	3.243
Gorgol (04)			
14. Kaédi	13.30	16.09	20.221
15. M'Bout	13.34	16.01	30.908
16. Maghama	12.50	15.30	4.486
Guidimaka (10)			
17. Sélibaby	12.11	15.32	1.324
18. Ould Yenge	11.43	15.32	1.324
19. Gouraye	12.26	14.54	554
Tagant (09)			
20. Moudjéria	12.20	17.52	1.935
21. N'Beika	12.14	17.58	1.010
22. Aghlambit	11.55	18.25	773
23. Tidjikja	11.27	18.33	7.326
Assaba (03)			
24. Boumdeid	11.20	17.28	662
25. Kiffa	11.31	15.46	9.653
26. Kankossa	11.31	15.56	1.620
27. Aïn Teiss	11.09	15.37	295
28. Laouessi	12.12	16.18	975
29. Brakewol	12.28	16.38	2.012
30. Ghabra	12.39	16.39	1.467

Region	Longitude	Latitude	Population
Hodh El Gharbi (02)			
31. Tamchakett	10.40	17.14	937
32. Aïoun El Atrouss	09.36	16.39	5.245
33. Koboni	09.25	15.52	1.206
34. Touil	10.09	15.33	681
Hodh El Chargui (01)			
35. Timbedra	08.09	16.14	5.104
36. Néma	07.16	16.37	7.577
37. Oualata	06.59	17.18	1.059
38. Bassikounou	05.57	15.52	1.785
39. Abdèl Bagrou	07,03	15.32	2.177
40. Bousteila	08.05	15.34	1.099

The distribution of the observation towns and villages is as follows:

a.	dunes and sandy plains	13 site
b.	rags and clayey-sandy plains	12 sites
c.	sandstone massives and surroundings (Tagant, Assaba, Affolé, Dhar Néma Oualata)	9 sites
d.	Senegal River valley	6 sites
	TOTAL	40 sites

Rainfall data are given in Table 16 (Column 2) with corresponding latitudes for each observation site.

The preceding study of "Major Agro-Ecological Zones" (see Bibliography) has already examined, in a general manner :

- the characteristics of the Mauritanian climate (wind, temperature, rainfall, evaporation, humidity)
- major physical, hydrological, hydrogeological and pedological characteristics of Mauritania.

These basic caracteristics will not be rediscussed in this study.

Latitudes of Towns and Villages, from North to South

Number of Sites	Latitude North
2	Between 18 and 19°
13	Between 17 and 18°
13	Between 16 and 17°
11	Between 15 and 16°
1	Between 14 and 15°

Total 40

3.4.2. POPULATION DATA

The southern third of the country contains about 80% of its population. Table 1 in Chapter 2 shows the size of the population which has become sedentary. All of the ethnic groups in the country are represented in the southern third of Mauritania (Moor-Beidane and Haratine, Wolof, Toucouleur, Peul, Soninké and a few Bambara in the far southeast). This population is unequally distributed and concentrated mainly along the Senegal River and in the Guidimaka.

Table 7 shows population density for certain regions and departments covered by this study. It shows the heavy population concentrations of the Gorgol (11.01 inhabitants/km^2) and the Guidimaka (8.09 inhabitants/km^2).[16/]

Livestock raisers are generally: Moors, Haratines and Peuls;

Cultivators are generally: Soninké, Wolof and Toucouleur.

However, the drought has provoked disturbances which have somewhat blurred the distinction between livestock raisers and cultivators. Many livestock raisers have begun to farm crops, either part-time or on a permanent basis. On the other hand, few farmers have become livestock raisers (with the exception of occasional sedentary livestock raising around towns and villages).

A recent study done by the Sociology Unit of the RAMS project [17/] the interest of farmers in owning animals.

16/ Statistics from Central Census Bureau, IRM, January 1, 1977.

17/ Le Devenir du Pastoralism : trois cas - Etudes de terrain, Abdel Wedoud ould Cheikh, 1980.

Table 16 (Column 4) shows the main activities for each location studied (Chapter 3-4-5).

3.4.3. ANALYSIS OF FIELD STUDY RESULTS

It is clearly apparent that human and livestock populations play the major role in the destruction of vegetation cover around towns and villages, and that deficient rainfall plays a secondary role in this destruction.

Proof of this was provided by observation of zones, which have been protected by metal fencing of branches (zeribas), under latitudes receiving scant rainfall (see Table 9, Column 2), near the towns of Boutilimit, Kiffa, Boumeid, Aïn Salama and Keur Macène.

The case of Boumdeid is especially interesting. The Ideïboussats, a religious community, fenced a vast area with zéribas, inside of which cutting of green wood has been forbidden for many years (this protected area existed well before the drought). The results are spectacular: whereas everywhere else around Boumdeid the vegetation cover is extremely degraded and disappearing, in the Idéïboussat enclosure vegetation is luxurient and dense, with large, healthy trees (dominated by *Acacia raddiana*).

TABLE 7: (Source : Census Bureau 1/1/1977 - IRM)

Department	Surface Area Km2	Total Pop. Dens.	Nomadic Pop. Density	Sedentary Pop. Density
Amourj	9,300	2.94	1.53	1.41
Bassikounou	16,500	1.10	0.72	0.38
Djiguéni	3,600	5.73	2.03	3.70
Néma	9,900	4.25	2.21	2.04
Oualata	134,000	0.12	0.10	0.02
Timbédra	9,100	3.34	1.86	1.78
Region 1	182,700	0.86	0.47	0.39
Aïoun	17,900	1.85	0.72	1.13
Koboni	9,500	2.98	1.19	1.79
Tamchakett	14,600	2.45	1.96	0.49
Tintane	11,400	2.36	0.98	1.38
Region 2	53,400	2.32	1.20	1.13
Aftout	6,700	4.74	1.34	3.40
Boumdeid	4,500	2.79	1.30	1.76
Guérou	2,600	5.78	1.97	3.81
Kankassa	11,700	2.27	0.55	1.72
Kiffa	10,900	3.82	1.61	2.21
Region 3	36,600	3.52	1.18	2.34
Kaédi	4,000	13.67	1.23	12.44
Maghama	2,600	9 67	-	9.67
M'Bout	5,200	9.33	1.35	7.97
Mouguel	1,800	11.92	2.57	9.35
Region 4	13,600	11.01	1.22	9.79

Department	Surface Area Km2	Total Pop. Sens.	Nomadic Pop. Density	Sedentary Pop. Density
Aleg	16,300	2.63	1.37	1.25
Bababé	900	18.80	1.85	16.95
Boghé	1,600	22.23	3.60	18.63
Magta-Lahjar	13,600	2.50	1.47	1.02
M'Bagne	600	36.32	1.63	34.69
Region 5	33,000	4.58	1.54	3.04
Boutilimit	28,400	1.96	1.17	0.79
Keur Macène	2,800	7.65	4.71	2.94
Mederdra	7,700	5.57	3.20	2.37
Ouad Naga	19,800	0.63	0.44	0.19
R'Kiz	7.700	6.00	2.62	3.38
Rosso	1,400	26,08	4.31	21.76
Region 6	67,800	3.17	1.56	1.61
Moudjéria	11,800	2.70	1.98	0.72
Tichitt	68,200	0.08	0.06	0.02
Tidijikja	15,200	2.57	1.08	1.49
Region 9	95,200	0.80	0.46	0.34
Ould Yenge	3,700	6.32	0.87	5.46
Sélibabi	6,600	9.08	0.92	8.17
Region 10	10,300	8.09	0.90	7.19

TABLE 8

Main Ethnic Groups of the Sites Visited

LOCATION	MAIN MOORISH TRIBES	MAIN ETHNIC GROUPS
1 Ouad Naga	----------	Moors
2 Aïb Salama	----------	Moors
3 Baraïna	----------	Moors
4 R'Kiz	----------	Moors
5 Medardra	Trarza, Tachamcha	Moors
6 Rosso	Many mixed tribes	Mixed
7 Keur Macene	Oulad Akchar, Allouli, Tendgha	Moors, Wolof
8 Tiguent	Nombreuses dont Medlech, Oulad Bouzbao, etc...	Moors
9 Aleg	Idieyjeba, Hyjaz, Kounta, El-Hijaz	Moors
10 Bou Ghbeira		Moors
11 Choggar	Ouled Ahmed-Oulad Abieri-El Hijaz, Soubab-Darawa	Moor
12 Dionaba	Tirkhiz-Tagats-Temendeng	Moors, Haratine
13 Bababé	Mixed	Toucouleur, Peul, Moors
14 Kaédi	Mixed	Soninké, Toucouleur, Peulh, Moors
15 M'Bout	Cherfa-Tadjakant-Chratit	Moors, Peulhs,
16 Maghama	Mixed	Toucouleur, Peulh, Moor
17 Sélibali	Messouma - Z'henat-Ta - Joumet	Moors, Soninké
18 Ould Yange	----------	Moors, Peulhs
19 Gouraye	----------	Toucouleur, Bambara, Moor, Soninké
20 Moudjeria	Idawali, Kounta, Irawich, Torkoz	Moor
21 N'Beika	Kounta	Moors
22 Aghlambit	Kounta	Moors
23 Tidjikja	Idawali-Kounta	Moors
24 Boumdeid	Idaïboussat	Moors
25 Kiffa	Ahmed Sidi Mahoud-Idawaïch	Moors and others

LOCATION	MAIN MOORISH TRIBES	MAIN ETHNIC GROUPS
26 Kankossa	Ahmed Sidi Mahmoud	Moors and Peulhs
27 Aïn Teiss	Ahmed Sidi Mahmoud	Moors
28 Laouessi	Tadjakant-Ideyla	Moors
29 Barkeol	Tadjakant	Moors
30 El Ghabra	Tadjakant	Moors
31 Tamchakett	Laghlal-Idaïboussat	Moors
32 Aïoun El Atrouss	Laghlal-Oulad Nasser	Moors
33 Koboni	Oulad Nasser-Oulad M'Bareck	Moors
34 Touil	Tadjakant	Moors
35 Timbedra	Meodeuf	Moors
36 Nema	Ahmed Moulaye Smaïl	Moors and Peulhs
37 Oualata	Kounta	Moors
38 Bassikounou	Oulad Daoud	Moors, Peulh, Others
39 Abdel Bagrou	Oulad Bou Houmoud	Moors, Peulhs
40 Bousteilla	Machdeuf	Moors

At cheggar, one green area was immediately noticed in an otherwise almost barren landscape: it was the cementary, populated by large Acacia raddiana; these trees had not been exploited due to religious fears.

As to grass cover, a metal-fenced perimeter several kilometers from Boutilimit was observed in May (at the end of the dry season) to contain a fairly dense grass carpet, whereas everywhere else the sandy soil was fairly barren.

This demonstrates that even with an inclement climate, vegetation can survive under certain conditions.

Intensive cutting, trampling and over-grazing due to heavy human and animal concentrations are directly responsible for the thinning, or disappearance of vegetation cover.

A number of summary tables show the correlations between different factors leading to destruction of the vegetable cover (causes) and the effects observed on the lands around towns and villages.

3.4.3.1 SEDENTARY LIVESTOCK

Large herds of sedentary livestock were found in almost all locations studied. These animals (according to type) ranged over an area of from 2 to 20 kilometers from the towns.

Table 9 (Sedentary Livestock Population) shows the ranging areas of these animals by category 18/. It shows the predominance of goats

18/ Table 9 is based on data from field surveys. In so far as possible, information was sollicited from village elders, representatives of livestock associations and the herdsman themselves.

and sheep, which are the most destructive of trees (especially goats, which eat the leaves and young shoots and which can easily climb the thorny shrubs in order to consume the green shoots higher up).

Goats will eat almost all types of vegetation. In certain regions, we observed these animals eating the leaves and shoots of a toxic shrub (Calothropis procera), as this was the only plant available during the dry season. According to herdsmen, this is a new phenomenon, which demonstrates the goats' great capacity to withstand and adapt to the existing environmental conditions.

Sheep and goats literally "level" the soil surface as soon as the smallest plant appears. These animals are extremely harmful to vegetation and prevent maintenance of the vegetation cover. In addition, since goats and sheep must drink rather frequently, they do not range far from the town or village (ranging rarely exceeds 5 km from the town, when they are without a herdsman). Their limited ranging area thus increases pressure on the environment around towns.

Cattle are the second category of sedentary livestock (in much smaller numbers than goats and sheep). As they are primarily grass eaters they suffer from a severe lack of green forage in almost all of the southern third of Mauritania during the long dry season (October to July). Most herds migrate during this period to Mali or to Senegal in search of pasturage. A small amount are sedentary around towns and villages (mainly weak or young animals, or milch cows).

TABLE 9 SEDENTARY LIVESTOCK POPULATION

TOWN NUMBER	CATTLE (HEADS)	RANGING DISTANCE	SHEEP GOATS (HEADS)	RANGING DISTANCE	CAMELS (HEADS)	RANGING DISTANCE	DONKEYS (HEADS)	RANGING DISTANCE
TRARZA								
1. Ouad Naga	10	5 km	1.150	5 km	60	5 km	25	5 km
2. Aïn Salama	130	20 km	2.300	20 km	500	20 km	90	-
3. Baraïna	400	-	150	2 km	200	5 km	100	-
4. R'Kiz	2000	15 km	2.100	5 km	600	7 km	6	-
5. Mederdra	20	20 km	9.000	4 km	60	5 km	300	10 km
6. Rosso	500	15 km	20.000	2,5 km	1080	20 km	300	2 km
7. Keur Macene	70	8 km	230	autour du village	-	-	3	
8. Tiguent	200	10 km	2.000	2 km	100	12 km	20	-
BRAKNA								
9. Aleg	80	15 km	300	15 km	20	15 km	200	-
10. Bou Ghbeira	1000	10 km	500	15 km	20	15 km	1000	-
11. Choggar	Non estime	15 km	Non estime	2 km	100	-	100	-
12. Dionaba	200	5 km	600	5 km	16	5 km	16	5 km
13. Bababe	400	10 km	3000	7 km	-	-	600	-

(1) These livestock population figures are very approximate and cannot be considered official.

Source: RAMS Survey, 1980

Table 9 (Cont'd)

TOWN NUMBER	CATTLE (HEADS)	RANGING DISTANCE	SHEEP GOATS (HEADS)	RANGING DISTANCE	CAMELS (HEADS)	RANGING DISTANCE	DONKEYS (HEADS)	RANGING DISTANCE
GORGOL								
14. Kaedi	1.500	15 km	10.000	7 km	-	-	1.500	-
15. M'Bout	2.000	8 km	4.000	3 km	-	-	1.000	-
GUIDIMAKA								
16. Maghama	3.500	12 km	5.000	10 km	68	-	200	-
GUIDIMAKA								
17. Selibali	2.000	10 km	6.000	7 km	-	-	2.000	-
18. Ould Yenge	600	9 km	1.000	9 km	-	-	200	9 km
19. Gouraye	1.000	10 km	700	10 km	-	-	700	10 km
TAGANT								
20. Moudjeria	-	-	350	10 km	20	20 km	40	-
21. M'Baika	50	7 km	2.200	5 km	300	15 km	700	-
22. Aghlambit	40	5 km	400	3 km	30	5 km	100	-
23. Tidjikja	3.000	5 km	6.000	5 km	5.000	3 km	10.000	-
ASSABA								
24. Boumdeid	100	6 km	13.200	3 km	10	6 km	400	2 km
25. Kiffa	300	8 km	1.200	5 km	120	13 km	450	around the town
26. Kankossa	30	10 km	1.000	5 km	-	-	20	1 km
27. Aïn Tess	20	3 km	50	3 km	-	-	3	around the village
28. Laouessi	100	10 km	80	5 km	-	-	50	-
29. Barkewol	200	6 km	1.000	3 km	20	1 km	200	-

Table 9 (Cont'd)

TOWN NUMBER	CATTLE (HEADS)	RANGING DISTANCE	SHEEP GOATS (HEADS)	RANGING DISTANCE	CAMELS (HEADS)	RANGING DISTANCE	DONKEYS (HEADS)	RANGING DISTANCE
30. Ghabra	200	5 km	2.300	5 km	7	-	150	-
HODH EL GHARBI								
31. Tamchakett	700	-	1,300	7 km	300	-	100	7 km
32. Aïoun	1.000	7 km	1.500	3 km	100	12 km	200	2 km
33. Koboni	800	8 km	300	3 km	-	-	50	3 km
34. Touil	1.000	6 km	1.000	5 km	-	-	100	1 km
HODH EL CHARGUI								
35. Timbedra	5.000	12 km	2.000	5 km	700	8 km	2.000	1 km
36. Nema	1.000	10 km	1.000	3 km	-	-	700	3 km
37. Oualata	500	15 km	300	7 km	300	-	200	7 km
38. Bassikounou	2.000	15 km	400	3 km	400	8 km	100	1 km
39. Abdel Bagrou	1.500	20 km	3.000	5 km	-	-	300	-
40. Bousteila	1.000	7 km	1.200	2 km	-	-	300	1 km

Sedentary cattle usually range over a distance of 5 to 10 km (at times as far as 20 km) in search of meager forage. Straw is quite rare, often localized in depressions. These animals must feed on the leaves of various woody species, which are neither abundant nor of high nutritive value.

Herdsmen supplement their cattle's diet with scrap paper and cardboard boxes, occasionally with purchased animal feed.

Due to their weight and heavy concentration, sedentary cattle trample the soil and young trees.

"Sedentary" camels are much less numerous; they are usually milch cows, young pack animals or animals brought to the town for sale. They destroy shrubs and trees ("aerial pastures") as they are able to reach the higher branches and are not bothered by thorns. As will be seen later, they are often quite selective of the species they consume.

Note: Sedentary camels are located mainly to the north of the 300 - 350 mm isohyetal line, as they do not prosper in the more humid southern zones (especially during the rainy season), where they are apt to contract a variety of diseases.

Donkeys are quite numerous in all the towns and villages observed, as they are extremely useful to man for the drawing of water and the transport of guerbas, merchandise or man, etc.

In addition, donkeys will eat practically anything: paper, cardboard boxes, dead wood and other waste material.

They are very destructive of vegetation, particularly near towns, from which they rarely stray. These donkeys do not appear to suffer from the lack of pasturage near towns.

SPECIES CONSUMED BY ANIMAL CATEGORY 19/

Goats and donkeys, as mentioned before, will eat all available and accessible species.

Sheep are slightly more selective, and will not eat *Calothropis procera*.

Cattle are able to tolerate more or less well during the dry season a certain number of trees and shrubs, a list of which is given below.

- Gapparis decidua
- Balanite aegyptiaca
- Zizyphus mauritiana
- Mytragina inermis
- Tamarix aphylla
- Acacia albida
- Acacia nilotica
- Acacia senegalensis
- Acacia raddiana
- Pterocarpus crinaccus
- Maerua crassifolia
- Acacia flava
- Acacia seyal
- Combretum glutinosum
- Guiera sénégalensis
- Grewia bicolor
- Bauhinia reticulata
- Leptadenia Spartium
- Combretum micranthum
- Combretum aculeatum

The above list represents about 50% of the woody species censused for the 82 observation sites of this study.

19/ Based on 40 field questionnaires.

Among these species, the most appreciated by cattle seem to be Maerua crassifolia and Capparis decidua, usually located in inter-dune depressions.

However, often cattle have no choice and must eat less appetizing species such as Boscia senegalensis, almost always found in clayey-sandy rags.

Camels: Camels consume a more limited number of woody species, but their height allows them to reach the branches which are not accessible to smaller animals. The species most appreciated by camels are:

- Leptadenia spartium
- Acacia senegal
- Acacia raddiana
- Balanites aegyptiaca
- Capparis decidua
- Acacia flava
- Maerua crassifolia

Camels consume mainly these woody species, which are the most common species in the southern third of Mauritania (see table of frequency of species, Chapter 3-3). Example: Balanites aegyptiaca = 15% of observations (111 transects).

3.4.3.2 GRASS PASTURES

Grass pastures are very rare during the dry season and can only be found in the lowlands and valleys. Towards the south, in the Guidimaka, in the "new world" and in the southeast along the Malian border, grasslands are less sparse due to more abundant rainfall (500-600 mm/year during good years).

However, due to the persistant drought, these pastures are decreasing and have even disappeared in some regions. Before the drought, dried grasses and straw were abundant during the dry season, often lasting until the following rainy season, thus permitting "carry-over" of herds. The presence of a large network of firebreaks in zones which are at present totally barren of vegetation cover attests to this disappearance of grass pastures.

Grass pasture lands, which are already scarce elsewhere, are almost totally lacking around villages and towns, as shown by Table 10.

The rare straw which occasionally can be found is not sufficient to feed large herds. Even with adequate rainfall, the pressure from animals does not permit maintenance of a new grass cover during the dry season.

3.4.3.3 HUMAN ACTIONS

A ministerial circular of September 13, 1978, sent by the Ministry of Rural Development to "all governors and all regional Rural Development Services", forbids the cutting of green wood throughout Mauritania.

Nevertheless, the local population continues unhindered to exploit the existing meagre vegetation cover. When reminded that this is forbidden, they argue that they have not choice but to cut, if they are to feed their livestock, construct fences, etc. The Nature Protection Service and other services which can sanction infractions have very limited means of surveillance, and most cutting is done without their knowledge.

Thus, human actions are very destructive to vegetation cover, particularly around towns and villages.

1) Cutting to Feed Livestock

In order to feed their livestock, villagers chop branches from trees and shrubs, particularly the higher branches which most animals (except camels) cannot reach. Larger branches are partially split from the trunk and hang down from the tree, giving it an "umbrella" appearance. This practice is obviously extremely harmful to the plant.

Table 11 shows that certain species are more frequently cut to feed livestock: Balanites aegyptiaca, Acacia raddiana, Capparis decidua, Acacia seyal, Acacia senegal, Acacia nilotica.

2) Other reasons for Cutting

Table 12 gives the different uses of vegetation, based on the questionnaires from the survey of 40 towns and villages.

TABLE 10- 0 - present ; ÷ - absent

TOWN/VILLAGE NUMBER	GRASS COVER	COVERAGE RATE (%)	TOWN/VILLAGE NUMBER	GRASS COVER	COVERAGE RATE (%)
1	0	< 5	21	0	∓ 40
2	0	< 5	22	0	∓ 20
3	0	±20	23	0	± 40
4	÷		24	0	< 5
5	0	< 5	25	0	< 5
6	0	± 60	26	0	< 5
7	0	// 20	27	0	± 20
8	0	< 5	28	÷	
9	÷		29	0	< 5
10	0	< 5	30	0	< 5
11	÷		31	0	< 5
12	÷		32	÷	
13	÷		33	0	< 5
14	0	< 5	34	0	< 5
15	÷		35	÷	
16	÷		36	÷	
17	0	< 5	37	0	< 5
18	0	< 5	38	0	± 30
19	0	< 5	39	0	< 5
20	0	± 0	40	÷	

TABLE 11 - SPECIES CUT TO FEED LIVESTOCK (BASED ON QUESTIONNAIRE OF TOWNS/VILLAGES)

X: TREES CUT (40 TOWNS AND VILLAGES) O : PRESENT

TOWN NUMBER	BALANITES AEGYPTIACA	ACACIA RADDIANA	CAPPARIS DECIDUA	ACACIA SEYAL	ACACIA SENEGAL	OTHER SPECIES CUT
1.OUAD NAGA	0	0	0		0	Maerua crassifolia Comophora africana
2.AIN SALAMA	0	0	0			Maerua crassifolia
3.Bareina	X	X	X		0	
4.R'Kiz	0	X	X		0	Acacia flava Acacia nilotica
5.Mederdra	X	X			X	
6.Rosso	X	X		X		Acacia albida Tamarix Aphylla
7.Keur Massene						Acacia Albida Acacia nilotica
8. Tiguent	0	X			X	Maerua crassifolia
9.Aleg	X		X		X	Boscia senegalensis
10 Bou Ghbeira	0	X	0		0	Boscia senegalensis Maerua crassifolia
11.Choggar	X		X			Maerua crassifolia Acacia flava
12.Dionaba	X		X	0		Acacia nilotica Ziziphus mauritania

Table 11 (Cont'd)

TOWN NUMBER	BALANITES AEGYPTIACA	ACACIA RADDIANA	CAPPARIS ACIDUA	ACACIA SEYAL	ACACIA SENEGAL	OTHER SPECIES CUT
13.Bababé	X	X	X	X	X	Boscia senegalensis
14.Kaedi	X	0		X		Acacia nilotica Bauhinia reticulata
15.M'Bout	X	X	X			Acacia flava
16.Maghama	X	X	X	X	0	Grewia bicolor
17.Selibali	X	X	X		0	Grewia bicolor
18.Ould Yenge	X				X	Sclerocarya Birrea Hyphaene thébaïca
19.Gouraye	X		X	X		Guiera senegalensis Acacia nilotica
20.Moudjeria	X	X				Acacia flava Acacia crassifolia
21.M'Beika	0	X				Acacia flava Acacia nilotica
22.Aghlambit	0	X	X	0		Salvadoria persica
23.Tidjikja	0	0				Maerua crassifolia Calothropis procera
24.Boumdeid	0	0	0			Maerua crassifolia
25.Kiffa	X	0			X	Acacia flava

TABLE 11 (CONT.)

TOWN NUMBER	BALANITES AEGYPTIACA	ACACIA RADDIANA	CAPPARIS ACIDUA	ACACIA SEYAL	ACACIA SENEGAL	OTHER SPECIES CUT
26. Kankossa	0	X		X		Combretum glutinosum Grewia bicolor
27. Aïn Teiss	C				0	Bauhinia reticulata
28. Laouessi	0	0	0	0	0	Acacia flava
29. Barkewol	X	0	0		0	Bauhinia rufescens
30. Ghabra	0		0	0		
31. Tamchakett	0	0	0			Acacia flava Commiphora africana
32. Aïoun	0	0			0	Acacia flava
33. Koboni	X			X	X	Bauhinia réticulata
34. Touil	X			X	0	Guiera senegalensis
35. Timbedra	X	X		0	X	Acacia flava
36. Néma	0	X		X	X	
37. Oualata	0	X		0	0	
38. Bassi Kounou	C	0		0	0	
39. Abdel Bagrou	X	0		X	0	Acacia flava
40. Bousteila	0			X	X	Grewia bicolor

TABLE 12

CODE	USE	NUMBER OF OBSERVATIONS (40 QUESTIONNAIRES)
A	Beams and balks for roofing	38
B	Wood charcoal	25
C	Bark ropes	15
D	Handles for agricultural tools	11
E	Mortors, pestals, bowls	8
F	Firewood	7
G	Guribas (branch, fences)	7
H	Well forks and pulleys	4
I	Handicraft items	
J	Bedding	
K	Bark to waterproof guerbas	
L	Mats	2

Table 12 shows that the two major reasons for cutting woods are for the construction of roof beams and balks and for wood charcoal.

The Mauritanian sedentary populations construct "banco" housing, which requires a beamed roof. The newer "sedentary" populations are mainly former tent-dwelling nomads (Moors and Haratines). Wood supplies, which were once sufficient for a small population of cultivators, now no longer suffice; many species are sacrified to supply housing due to increased sedentarization.

In addition, the consumption of wood charcoal has increased in urban centers. In small villages or camps, gathering of dead wood was sufficient for fire building. However, in towns, the population requirements are such that to find dead wood one must often go quite far. Most wood charcoal comes from Senegal River valley. The main wood employed is Gonakié (Acacia nilotica), which furnishes excellent charcoal, especially when cut green. This tree is disappearing, due to over-exploitation. (The case of the Gonakié will be examined in Chapter 3-7, "State of Classified Forests").

Table 13 shows the species cut according to the utilization of the wood.

TABLE 13

SPECIES	USE CODE (SEE TABLE 17)
Acacia nilotica	A-B-D-G
Balanites aegyptiaca	A-D-E-F-G-H
Mitragyna inermis	A-G-J
Acacia raddiana	A-B-F-K
Acacia senegal	F
Selerocarya birréa	E-I
Combretum glutinosum	A-B-J
Grewia bicolor	B-F
Guiéra sénégalensis	F
Bauhinia Reticulata	E
Hyphaene thébaïca	A-E
Ptérocarpus eraneceus	A
Anogeissus léiocarpus	A
Bauhinia rufescens	A-G
Zizyphus mauritiana	G
Borassus flabellifer	A-L
Bombax costatum	A-J
Adansonia digitata	C
Dalbergia melanoxylon	D
Combretum aculeatum	A-G
Calothropis procera	A-J
Acacia flava	B-K
Capparis decidua	A-H
Commiphora africana	A-I-K
Acacia seyal	F-K
Panicum turgidum	A
Maerua crassifolia	A
Boscia sénégalensis	A

Total: 28 Species

After examination of Tables 12 and 13, a few remarks on the use of certain species are in order (in particular, Balanites aegyptiaca, Acacia nilotica and Acacia raddiana, the most sought-after).

Balanites aegyptiaca is a thorny tree which can attain a height of 5 meters. Its wood serves for more than half the uses surveyed. This would seem to be due to the fact that many other species are becoming rarer and villagers are forced to use this tree, which is becoming dominant (15% of species observed during 111 transects). (See Table 11, Chapter 3-3).

Balanites aegyptiaca wood is fairly hard and has multiple uses. In certain regions, this is practically the only tree found, which attests to its resistance to animal and human depredations and to drought (its resistance to drought will be examined in a later section). This tree also has the ability to grow new shoots in places where it has been cut or gnawed by animal teeth. Balanites aetyptiaca is found on practically all types of soil.

Acacia raddiana is a thorny tree which can reach (under certain favorable humidity conditions, such as found in lowlands or the edges of oueds) a height of more than 6 meters. It is extremely common throughout the entire sector under study (frequency: 8.2%, see Table 11, Chapter 3-3). It is usually found on sandy soils and is more common to the north of the 400-500 mm isohyetal line (it can even be found north of the 200 mm isohyetal line).

Acacia raddiana wood is sought-after for multiple uses, from beam construction to the stripping of its bark for water-proofing guerbas. It is also employed for wood charcoal.

However, this wood is not good for the fabrication of utensils, tools or handicraft items.

Acacia nilotica, a large tree, is less frequently encountered than the two preceding species (frequency: 5.4%, see Table 11, Chapter 3-3). These trees are concentrated mainly in the Senegal River valley and along oueds, Their wood is excellent for charcoal and is greatly sought-after. Acacia nilotica is at present being presently over-exploited; uncontrolled cutting is causing far more depradation than the drought. (This subject will be examined later in the study).

Other species are of lesser importance, except Acacia senegal, which provides gum arabic. However, massive uncontrolled bleeding over many years considerably weekened these trees, which were then decimated by the drought. This is especially evident in the Trarza where there are veritable "gum tree cementaries".

The insignificant quantity of gum arabic marketed by SONIMEX 20/ last year reflects the precarious state of the gum tree forests. (The case of gum trees will be examined in Chapter 3-9).

3) PROBLEMS DUE TO ZERIBAS (Branch Fences)

In order to protect their crops (or corral livestock), farmers construct fences of branches. These are called "zeribas" and are found throughout Sahelian countries.

20/ In 1980, production of arabic gum was only 131 tons.

The most efficient and common type of zeribas is composed of thorny branches.

Protection of cultivated fields is a necessity, given the high concentration of freely ranging livestock around towns and villages. However, the cutting of green wood is forbidden and the farmers usually cannot find enough dead branches to build their zeribas. Metal fencing is too expensive. Thus, the farmers find themselves faced with a critical situation; they do not want to lose their harvests to various waundering animals (the extremely agile goats are the worst offenders). The farmers feel they have no choice but to ignore governmental restrictions. Since the Nature Protection Services have insufficient means to efficiently control wood cutting, the risk of sanctions is hardly a deterrent. In order to get around restrictions, branches are cut several kilometers from the village, far from "prying eyes", and left to dry on the site. Later, the branches will be brought to the village as "dead wood", supposedly gathered in the forest. These branches also serve to supplement livestock diets before they are used as zeribas.

The most frequently cut species are Bauhinia rufescens, Balanites aegyptiaca and Acacia nilotica, due to their "efficient" thorns. In regions where few thorny trees are found (and especially around the larger towns surveyed), the Calothropis procera bush is used for fencing. This shrub is typically found on depleted soils. Fences are composed of closely planted Calothropis stems. Calothropis fences were observed around the following towns:

M'Bout, Moudjeria, Aghlambit, Tidjikja, Boumdeid, Kiffa, Kankossa, Laouessi, Barkewol, Aïoun el Atrouss, Koboni, Timbedra, Bousteila. (Underlining of town names indicates abundant Calothropis procera, an indicator of highly impoverished soils).

CLEARING FOR CULTIVATION

Rural exodus and the resultant sedentarization have increased urban populations and resulted in increased cultivation around towns. The highest density of clearing for cultivation is found in the Senegal River valley (walo and diéri lands) and in the rainfed cultivation zone (particularly in the Guidimaka).

Clearing destroys the vegetation cover and concerns almost all species present on cultivable lands. It is rare to find a field in which even a few trees have been left to provide shade. The only tree not cut was found to be Acacia albida, as the farmers know this tree is useful for soil fertilization and provides a highly nutricious fodder (leaves and pods) for livestock. In addition, certain religious restrictions in the Senegal River valley may have originally prevented the cutting of Acacia albida.[21/]

The highest level of clearing for cultivation was observed around the larger towns of the Senegal River valley, particularly from Rosso to Kaédi. On the oualo lands around Rosso, one finds hundreds of hectares completely cleared. As far as the eye can see, the landscape is com-

21/ El Hadj Amadou Mamadou Camara, 1978, "Energy : Wood and Wood Charcoal", OMVS Study for Mauritania and Senegal.

pletely desolate: only a few tree stumps, many quite old, punctuate the countryside.

Many islets of clearing for cultivation have already ravaged the interior of classified forests and the protected Gonakié domains. Trees are felled with axes or machetes and the wood is used. During the construction of irrigated fields, the trees are cut down, leaving the surface of the soil bare, often for several years, before irrigation begins. During this period, it is prey to wind and water erosion.

In the southeast (rainfed cultivation zone), cultivation is more extensive and brush fires are traditionally employed to clear the land. However, the fairly severe government restrictions concerning brush fires has reduced use of this method. In addition, the disappearance of the dry season grass carpet and the marked sparcity of vegetation in general has tended to create a natural barrier to brush fires. This method could be used again, if sufficient and well distributed rainfall occurs.

Brush fires are extremely destructive, killing a great number of woody species, which require long periods to regenerate. They also eliminate a great deal of forage which would otherwise have been available to livestock. By denuding the soil surface, brush fires also favorize water erosion during the rainy season and wind erosion during the dry season. They also destroy surface organic matter and the heat destroys fauna in the surface of the soil.

3.4.3.4. THE DOUGHT AND VEGETATION

We have discussed the extremely destructive actions of man and animals on the vegetation cover. Near the towns and villages surveyed, the destructive impact of humans and their livestock was evident.

The drought has also considerably contributed to environmental degradation. However, around towns and villages, the drought's effects have been secondary to the actions of humans and animals.

The two main species found to be degraded near the 40 towns and villages were (by order of frequency) (see transect sheets in Annex):

1. Acacia senegal
2. Commiphora africana

Less frequently, the following species were found to be degraded:

- Acacia flava
- Acacia raddiana
- Balanites aegyptiaca
- Combretum glutinosum
- Sclerocarya birrea
- Grewia tenax
- Pterocarpus luscens

Note: Acacia nilotica (Gonakié) was rarely found in the transects conducted from the towns and villages surveyed, Elsewhere, (and particularly in the Senegal River valley), their withered condition is quite advanced. The Gonakié trees which survived the drought are now being cut for charcoal (this will be discussed in Chapter 3-7), "State of Classified Forests").

1. Acacia senegal

This thorny tree was often observed to be dead, but still standing, without apparent signs of cutting. At other times, these trees had

fallen into a pile of branches and debris. Acacia senegal were most affected by the drought in shifting-dune zones (particularly in the Trarza).

It would appear, however, that Acacia senegal was weakened by massive bleeding for gum arabic well before the drought. The drought precipitated the death of these trees. Thus the gum trees were victims of both human actions and deficient rainfall.

2. Commiphora africana

This tree, typical of Sahelian milieus, is characterized by its almost continual absence of leaves. It has a thick milky sap and is thus highly osmotic. Commiphora africana has not withstood the drought well and is often found to be withered, more so to the north of the 300 mm isohyetal line. The weak rooting system of this tree may partially explain this. As this species was rarely cut, it would seem that the drought was mainly responsible for its destruction.

3. Remarks concerning other common species

Balanites aegyptiaca was almost never found to be withered. This may be explained by several factors:

- this tree has a pivotal root which can descend to a depth of 19 meters, permitting access to water tables not available to other trees. It can thus resist the hydraulic deficits during drought.

- this tree possesses numerous long thorns and very small leaves, which limits transpiration
- this tree is quite resistant to termites (which since the drought began have considerably weakened or killed many plants)
- this tree is also resistant to intensive mutilation.

Acacia raddiana is rarely found to be withered and seems to have well resisted the effects of the drought. This is certainly due to its root system, which can attain deeper humid zones in the soil, its thorny branches and its small leaves. It can also withstand mutilation, such as cut branches or stripped bark, even during the current drought. This tree prefers a sandy or sandy-clayey soil.

3.4.3.5 SOIL DEGRADATION AROUND TOWNS AND VILLAGES

Degradation of the soil was quite marked around the locations surveyed and is related to the intense destruction of the protective vegetable cover.

Mechanical soil erosion, whether due to wind or water, should be distinguished from chemical depletion, which is lowering of fertility (or sterility) resulting from over-exploitation and insufficient fallowing of the land (at times, fallowing being altogether absent).

Wind erosion is characterized by:

- shifting dunes: new dunes are formed (as at Barkhane) or old dunes, which were once fixed by vegetation before the drought, become mobile.
- sand covers, which progressively invade cultivated fields and mask clayey depressions
- sand-filling of oueds.

Water erosion provokes both:

- gulleys and
- deposition filling.

Chemical depletion renders the soil unsuitable for cultivation. Only a few species, such as Calothropis procera, can grow on these impoverished soils, which become barren and thus more susceptible to wind and water erosion.

The frequency of "sand winds or storms" attests to the intensity of wind action, which is less and less hindered by vegetation screens.

SIZE OF DEGRADATION ZONES AROUND TOWNS AND VILLAGES SURVEYED 22/

(See Table 14).

The size of degradation zones around urban centers is quite variable. Certain trends may be considered as functions of geomorphological units and their associated soil types, but given the small observation sample (40 towns), it is preferable not to be too categoric.

22/ The term "zone" was preferred to "ring", as degradation is often not concentric around the town. The term "intense degradation zone" refers to areas where the soil surface is totally bare or hardly covered by vegetation.

TABLE 14

SIZE OF MARKEDLY DEGRADED ZONES AROUND TOWNS AND VILLAGES

NO	Population	Average Size (meters)	Soils	Topography	Geomorphological Unit
1	830	1,000 m	clayey-sandy	Inter-dune depression	Trarza dunes
2	1,192	50 m	Sand cover on clayey subsoil	Inter-dune depression	Trarza dunes
3	1,128	1,000 - 2,000 m	Fixed sandy soils	Inter-dune depression	Trarza dunes
4	1,744	500 - 1,000 m	soils clayey to clayey-sandy	Plain, edge of lake	South of Trarza Edge of lake R'Kiz
5	3,010	Several kilometers	Sandy soil on dunes, sandy-clayey soil in "gouds"	Flattened dune belts alternating with depressions	Trarza dunes
6	6,178	Several kilometers	Clayey-silty sandy soil with indurated surfaces	Zone of Senegal River plain	Large alluvial valley (Senegal River)
7	1,292	No clear-cut zone	Sandy soil on dunes. Clayey sandy soils in "gouds" clayey soil in Walo.	Succession of dunes and clayey lowlands on the edge of the Senegal River Walo lands	Large alluvial valley (Senegal River)
8	808	600 m	Sand	Small dunes	Trarza dunes

TABLE 14 (Cont.)

NO	Population	Average Size (meters)	Soils	Topography	Geomorphological Units
9	5,185	200 - 1,000 m	Aftout rag type, clayey-sandy with ferruginous gravel	Flat, slightly gulleyed relief of the Aftout	Irakna Aftout
10	376	1,500 m	Dune sands	Dune belts alternating with flat bottomed depressions	Irakna dunes
11	1,884	+ 1,000 m	Lowland, sandy clayey soils. Dune belts to the north	Flat relief on the edge of the Aftout	Contact zone between Aftout and Irakna dunes
12	957	500 m	Sandy and gravelly (quarty & schist)	Large dune overhanging a dam	Aftout
13	3,243	500 m	Gravel plains alternating with sand plains	Flat surface on the edge of Senegal River Walo lands	Major alluvial valley of Senegal River
14	20,[illegible]	Several kilometers	Sandy soil with gravel	Bare rock. Fairly flat relief	Major alluvial valley of Senegal River
15	3,908	1,000 m	Sandy-clayey soils, small gravel	Slightly rolling plain, cut by gulleys	M'Bout Aftout

TABLE 14 (Cont.)

NO	Population	Average Size (meters)	Soils	Topography	Geomorphological Units
16	4,4[illegible]5	± 1,000 m	Sandy to clayey sand soil	Plains bordering Senegal River	major alluvial valley (Senegal River)
17	5,872	1,000 m	Ferruginous and quartz gravel Tamped soil Sand covers	Relatively flat plain	Clayey-sandy stoney plain, with in selbergs
18	1,324	Indistinct Zone	Sandy on dunes clayey in lowlands sandstone gravel covers	Edge of Karakoro many marigots slightly rolling plain	Karakoro dunes
19	[illegible]54	Indistinct Zone	Rocky depressions clayey soil in lowlands	Fairly uneven relief sandy piedmonts	major alluvial valley (Senegal River)
20	1,935	700 to 2,000 m	Alternating clay and slabs of sandstone; Clayey substiatus	Piedmont west of Tagant. Plain surrounded by dune belts	Tagant massive (sandstone)
21	1,010	Indistinct Zone	Clayey silty soil	Tamourt Ennaaj valley, surrounded by Tagant heights	Tagant massive (sandstone)

Table 14 (Cont'd)

NO	Population	Average Size (meters)	Soils	Topography	Geomorphological Units
22	773	1,000	Rocky, bare soil on slope sandy soil in valley	Western valley of Oued el Abied, bordered on the east by Tagant plateau	Tagant plateau (sandstone)
23	7,326	500 to 1,000	Sandy soil ± fixed, rocky substratum	Sandy, large alluvial valley of Tijikja oued	Tagant plateau (sandstone)
24	662	500 to 1,000	sandy soil on clayey substratum	Flattened dunes slightly hilly relief	Sandy plain between Tagant and Assaba to the west and Affolé to the east
25	9,653	800 to 1,000	Little fixed sandy soil clayey-stoney soil in rag	Hilly dune relief. Alternating stoney rags and large basins	Same
26	1,620	1,000	Sandy soil alternating with depression zones on the edge of Karakoro dunes	Sandy plain on eastern border of Karakoro. Alternating dunes and interdune depressions	Karakoro dunes
27	295	Indistinct Zone	Clayey soil in lowlands and rocky soil on crests and slopes	Gulleyed and eroded surface on Affolé plateau	Affolé Plateau

Table 14 (Cont'd)

NO	Population	Average Size (meters)	Soils	Topography	Geomorphological Units
28	975	1,000 to 3,000 m	Rocky-clayey soil	Aftout Rag, flat terrain with numerous gulleys	Aftout rag
29	2,012	300 to 500 m	Sandy soil on clayey substratum	Flat Aftout zone with gulleys	Aftout rag
30	1,467	4,000 m	Fairly compact clayey and sandy soil in gulley lowlands	Ghabra oued plain clayey-stoney rag	Aftout rag
31	937	500 m	more or less fixed. sandy soil	Dune zone alternating with depressions	Affolé plateau (sandstone)
32	5,245	1,000 m	Sandy-clayey on rocky soil	Fold in Affolé sandstones	Affolé Massive (sandstone)
33	1,206	1,500 m	Clayey and stoney soil	relatively flat surface, slightly incized by a oued	sandy Hodh domain
34	681	4,000 m	Clayey soil with sand cover	Oued depression and small sand covers	Hodh clayey sandy domain

Table 14 (Cont'd)

ND	Population	Average Size (meters)	Soils	Topography	Geomorphological Units
35	5,104	4,000	Sandy and clayey soils	Tamourt valley plain and depression	Sandy Hodhs plains
36	7,577	2,000	Clayey and stoney soils	Dhar Néma piedmont rag (gentle slope)	Dhar Néma (sandstone)
37	1,059	4,000	Sandy soils with clayey and stoney zones	Oued valley surrounded by the Dhar Oualata rocky escarpments (sandstone)	Dhar Oualata (sandstone)
38	1,785	300 to 600	Very compact clayey soil	Plain, alternating low dunes and clayey plains	Clayey-sandy Hodhs plain
39	2,177	1,000	Compact clayey soil	Rather flat oned flood zone (slight depression)	Same
40	1,099	1,000	Clayey soil with sand cover	Plain	Same

Source: Author, RAMS, 1980

Villages with small populations located on rags or clayey-sandy plains had proportionately greater degradation zones than did larger villages or villages located in other physical milieus. These villages were:

Number inhabitants		Size of Degradation Zone
Laouessi	975	1,000 to 3,000 meters
Ghabra	1,467	± 4,000 meters
Touil	681	± 4,000 meters

One explanation may be that the rag or clayey-sandy surfaces are rapidly flooded by rainwater and filled by the fine soil particles they carry (clays and silts). This phenomenon is worsened by the disappearance of vegetation cover. Plant regeneration becomes very difficult, sometimes impossible, due to the indurated nature of the soil. As vegetation disappears (due to cutting, trampling , grazing and drought), the bare surfaces are enlarged, as most species cannot grow on such surfaces .

Sites with large populations also have large degradation zones (several kilometers), for which the limits are often difficult to determine in the field (examples: Rosso, Kaédi, Néma, Timbedra). However, certain sites have proportionately less extensive degradation zones given their larger populations and regardless of geomorphological units (see Table 14) (examples: Barkewol, Aïoun el Atrouss, M'Bout, Bababé, Aleg, Tidjikja).

In order to comprehend these apparent paradoxes, more detailed studies would be required.

Note: These are zones of marked degradation around towns and villages, where the soil surface is visible due to scarcity of vegetation (or total lack of vegetation). These degradation zones are more extended at the level of density and presence of plant species: we observed that the nearer we approached the town, the smaller the number of species. Inversely, the number of species increases over very variable distances as one leaves the town, and finally stabilized. An example is Ouad Naga, in the Trarza:

Following a northeasternly direction in the "goud" (inter-dune depression) from the edge of the village, the soil is covered in the following manner:

from 0 ± 100 meters - bare soil, clayey-sandy, invaded by sand, rare tufts of very small Leptadenia spartium ("Titarik", in Moor), with an average spacing of 30 - 50 meters.

from 1000 m to ± 5 km (3 miles) - Appearance of a greater number of species:

Leptadenia spartium

Commiphora africana

Maerua crassifolia

Acacia raddiana

Acacia senegal (very rare)

Capparis decidua

Balanites aegyptiaca

However, the vegetation cover is sparse and plants are spaced on an average of 20 to 30 meters.

At times, dried grasses are found: Panicum turgidum ("Markba" in Moor) and "Akchit" (Moor), which could not be identified as to species due to its advanced state of withering.

WIND AND WATER EROSION

1) Shifting Dunes

We observed that for all the towns located in sandy milieus (Trarza-Brakna dunes, sandy Hodhs plains), there are problems due to the shifting of free sands or of formerly fixed dunes, regardless of population size. However, dune shifting phenomena become worse as rainfall decreases (correlatively with the latitude towards the north).

Between the 17° and 18° latitudes north, shifting dune phenomena were observed to be greater than in other sandy geomorphological milieus (see Table 15 and 16) 23/

This would appear to be due to the fragility of the environment at this latitude, with an average rainfall (during a normal year)

23/ Mr. Christian Barral, or ORSTOM, noted during the seminar on desertification (Nouakchott, May 26-28, 1980) that he had encountered this phenomenon of intensification of shifting dunes between 17° and 18° latitude north in other Sahelian countries.

of 200 to 300 mm, which is insufficient given the increased sedentary population and its livestock.

Table 15 gives a list of shifting dune phenomena per site.

Table 16 (at chapter 3-4-5) complements Table 15 by giving: location of towns by latitude, degradation of soil, population, main activities and physical milieu. It shows that only those towns located in sandy milieus have problems with shifting dunes; at times, as at Bareïna and Tiguent, in the Trarza, houses are menaced by mobile sand. Some houses are pushed over, others are invaded by sand and become uninhabitable. On a long term basis, the entire town may be destroyed. Moudjeria below the Tagant, is literally invaded by sands from the vast dune belt to the west of the town. Over several months, tons of sand have invaded the courtyard of the Prefect's house.

Sand Covers

All the towns and villages surveyed were affected by sand covers. The questionnaires show that sand covers worsened during the drought. For certain sites near rags and clayey-sandy plains, sand covers did not exist before the drought. They are linked to the disappearance of vegetation cover, which formerly fixed the soil and served as a wind screen. Wind velocity is higher due to decreased vegetation resistance near the soil, so that fine particles are torn from the surface. The finer particles are carried high into the air and transported great distances, invading far-away rags, crop fields, etc. Comparison of aerial

TABLE 15

Town Number and Administ. Region	Houses Menaced by Dunes	Stationary Dunes before Drought	Shifting Dunes	Remobilized Dunes	Worst Year of Rainfall Defici
TRARZA					
1	FEW	YES	YES	YES	1972 - 1973
2	FEW	YES	YES	YES	1972 - 1973
3	VERY MANY	YES	YES	YES	1972 - 1973
4	NONE	NO DUNES	NO	NO	1972 - 1973
5	MANY	YES	YES	YES	1972 - 1973
6	NONE	NO DUNES	NO	NO	1972 - 1973
7	MANY	YES	YES	YES	1972 - 1973
8	VERY MANY	YES	YES	YES	1973 - 1975
BRAKNA					
9	NONE	NO DUNES	NO	NO	1973
10	MANY	MORE OR LESS	YES	YES	1979
11	FEW	YES	YES	YES	1972
12	VERY MANY	MORE OR LESS	YES	YES	1978
13	NONE	NO DUNES	NO	NO	1972
GORGOL					
14	NONE	NO DUNES	NO	NO	1972
15	NONE	NO DUNES	NO	NO	1979
16	NONE	NO DUNES	NO	NO	1978

TABLE 15 (Cont.)

Town Number and Admin. Region	Houses Menanced by dunes	Stationary Dunes before drought	Shifting dunes	Remobilized dunes	Worst Year of Rainfall deficit
GUIDIMAKA					
17	NONE	NO DUNES	NO	NO	1978
18	NONE	NO	NO	NO	1979
19	NONE	NO	NO	NO	1979
TAGANT					
20	VERY MANY	YES	YES	YES	1979
21	MANY	YES	YES	YES	1979
22	MANY	NO DUNES	YES	YES	1973
23	FEW	NO DUNES BEFORE THE DROUGHT	YES	YES	1979
ASSABA					
24	VERY MANY (12 STORES + 4 HOUSES COVERED)	YES	YES	YES	1972
25	FEW	YES	YES	YES	1979
26	NONE	YES	YES	YES	1968
27	NONE	NO DUNES	NO	NO	1979
28	NONE	NO DUNES	NO	NO	1969

TABLE 15 (Cont.)

Town Number and Admin. Region	Houses menaced by Dunes	Stationary Dunes before the drought	Shifting Dunes	Remobilized Dunes	Worst Year of Rainfall Deficit
29	NO	NO	NO	NO	1979
30	NO	NO	NO	NO	1973
Hodh El Gharbi					
31	Many	YES	YES	YES	1979
32	Few	YES	YES	YES	1973
33	Many (5 houses)	Dunes appeared	YES	YES	1979
34	None	NO	NO	NO	1971
Hogh El Chargui					
35	Few	Dunes appeared around 1969	YES	YES	1979
36	None	NO	NO	NO	1979
37	Many	YES	YES	YES	1979
38	None	NO	NO	NO	1974
39	None	NO	NO	NO	1974
40	None	NO	NO	NO	1969

photographs from 1952-54 and 1979-80 show the marked increase of sand coverage of the landscape.

Shifting dunes can be created in formerly bare zones by accumulation of these sand covers. This was observed outside the sandy zone, on the Akjoujt road. Very mobile crescent dunes ("Barkhanes") were formed everywhere over the bare rag and invaded the road.

For all field questionnaires, it was answered that sand winds had increased since the drought. This phenomenon is particularly harmful to vegetation, as plants are subjected to drying and whipping by moving sand particles.

Water Erosion

The destructive effects of water erosion are secondary to wind erosion. Due to the sparse and poorly distributed annual rainfall during the current drought, much of the water evaporates from the soil surface. In sandy areas, water infiltrates and there is practically no surface runoff.

However, on clayey-sandy surfaces and sandstone, runoff is possible. Water collects in oueds. Since there is sparse vegetation cover, runoff is rapid, creating gulleys in clayey-sandy geomorphological areas such as the Aftout. However, gulleys were not observed around most of the towns and villages surveyed (exceptions were: Rosso, Dionaba, El Ghabra, and Bousteila).

Throughout the Aftout, one finds deepening of exisitng gulleys; these do not, however, appear to affect the local populations.

2) Soil Depletion

Soil depletion is only discernible by laboratory analysis or by surveying cultivators. However, certain plants are excellent indicators of the agricultural potential of the soil.

In the southern third of Mauritania, when Calothropis procera is present, this indicates soil impoverishment; when Calothropis is particularly dense, the soil may be sterile.

On the edge of the town of R'Kiz, a strip of more than 1000 meters (located on the northeastern edge of the lake) is covered by a veritable "forest" of very large Calonthropis procera. This zone had been extensively cultivated and has become infertile. Other large belts of Calothropis were seen near Timbedra, Kiffa, Aïoun el Atrouss, M'Bout, and Moudjeria.

In the present situation of rainfed agriculture (between 350 and 650mm) in Mauritania 24/, beyond ecological and climatic conditions which constantly expose the milieu to such consequences, the techniques of this kind of agriculture only increase the vulnerability of this milieu to these consequences, leaking to serious deterioration in the ecological and socio-economic domains. In effect, these methods of cultivation do not ever consider the problems of restoring the soils or of conserving their structure and fertility, now undermined by inappropriate methods of cultivation and a non restitution to the soil of the elements removed by crops. This leads to a rapid exhaustion of the soil, causing farmers to give up their land either temporarily or permanently, especially in years of bad weather, for land or at least land that is more suitable for cultivation.

The main consequence of the phenomenon of land abandonment in rainfed agriculture is the exposure of particularly vulnerable soils to the dangers of deterioration through wind and water erosion.

Soil Asphyxiation - This affects recessional agriculture behind dams and in natural bottom lands: the more years the soil is cultivated, the more it is asphyxiated 25/, causing a drop in its agricultural value. This process seems to be most marked in the lowest parts of depressions, where pseudogleys form. This kind of deterioration is quite significant, affecting most areas that are cultivated after being submerged, but its seriousness depends on the duration of submersion and the alternation of dessication and water absorption.

24/ See subsector study on Rainfed Agriculture by Habib Kraiem, RAMS, 1980.

25/ Charles Toupet 1977.

3.4.4. ANALYSIS OF AERIAL PHOTOGRAPHS (1952-54 to 1979-80)

For the Sites of Mederdra, Boutilimit, Aleg and Selibabi (see Figures 11 through 14, Annex 1).

The comparative study of the changes over a period of 28 years around these towns is interesting in that it permits evaluation of the amplitude of desertification by direct visualization of past and present situations of each environment.

A. Mederdra (see Figure 9)

A geomorphological summary sketch was prepared based on the following aerial photographs (scale 1/50,000):

- AOF Mission 088 IGN, Jan. 20 - March 23, 1954, and
- OMVS Mission, Teledyne Geotronics, 2/8/1980.

The surface area covered by this sketch is about 98 km^2 (scale: 1/50,000).

The town of Mederdra was created well before Independance, it was an old colonial post, where the Circle Commander was based.

Urban Growth

There are no figures available for urban growth. The aerial photographs reveal very slight urban extension, but heavy increase of the density of dwellings within the former town limits. Tents dispersed around the town appear on the recent photographs.

Shifting Dunes

A shifting dune existed in 1954 (marked DV1 on sketch) to the southeast of the town. On 1980 photographs, this dune has extended towards the north (marked DV2).

LEGEND: Map of Mederdra 1954-1979 Figure 9
Study based on aerial photographs IGN 1954
and OMVS 2/8/1980 (Teledyne Geotronics)

Town of Mederdra

1 Zones apparently wooded in 1954, very sparse in 1980.

Present wooded area, in the "goud" - not visible in 1954

Live dune areas:

LD1: Live dune already existing in 1954

LD2: Live dune having appeared since 1954

LD : Live dune being formed

Goud (depression between dunes)

LZ: light-colored sandy zone

DZ: dark-colored sandy zone

– – – – Boundary between LZ and DZ

Number 2 zones to the east and west of town correspond to an area of deterioration already in existence in 1954.

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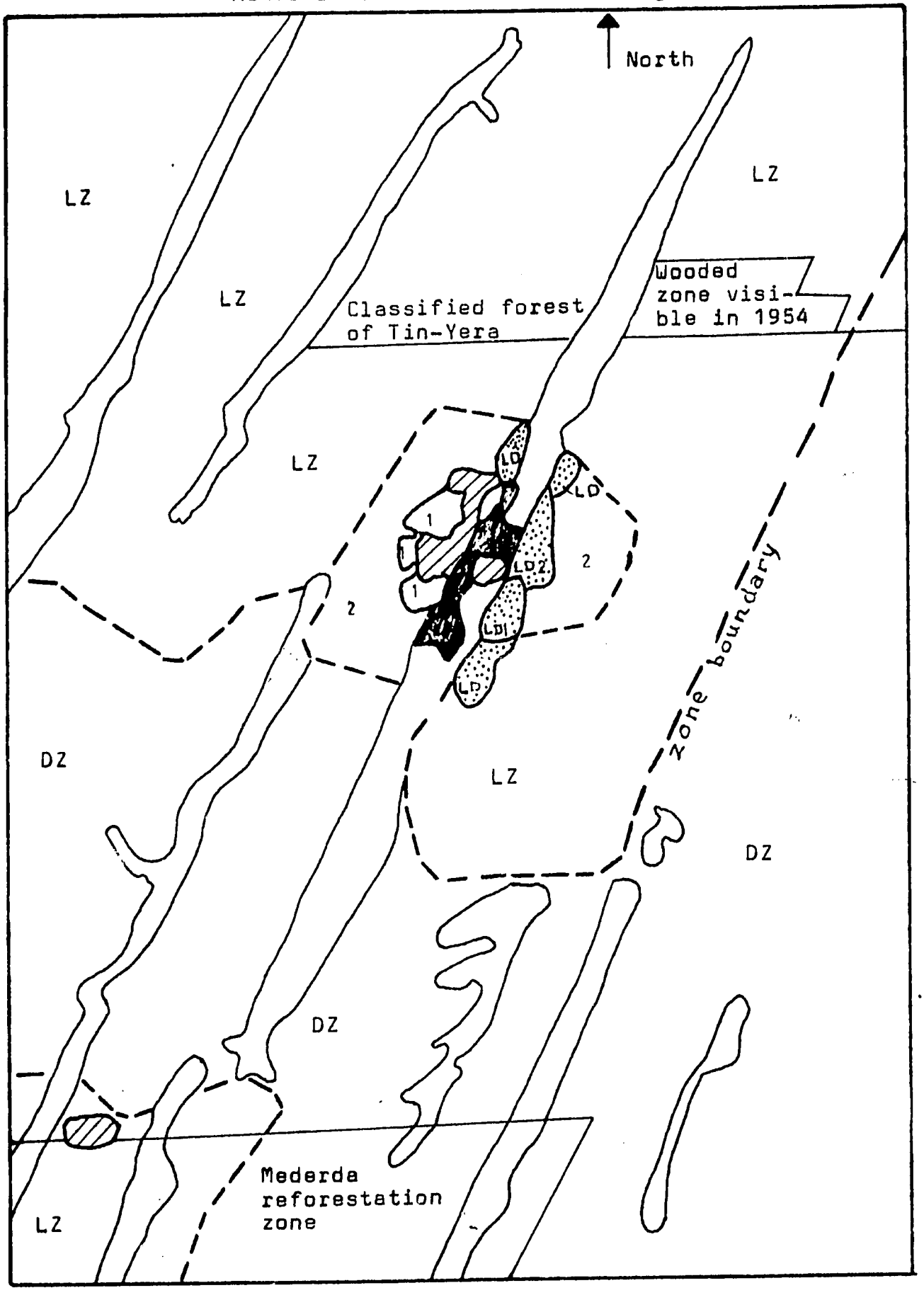
Mederdra 1954-1979 Figure 9.



Scale: 1/50,000 (see legend) 0 500 1000 1500 m

Source: Author (RAMS, 1980)

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In addition, three new dunes are forming (DF): one as a prolongation of the old dune (DV1) in the south, the second to the north of the new dune (DV2) and the third to the north of the town, on the other side of the "goud".

These dunes in formation are covered by only very sparse vegetation, which is tending to disappear. The shifting dunes DV1 and DV2 are totally bare.

Degradation of Vegetation Cover

Zone 2, around the town, corresponds to a degradation area already visible in 1954.

In 1980, a vast lighter-colored zone (ZC) appears, of the same type as Zone 2 in 1954. In this zone, the vegetation is less dense than in the darker-colored peripheral zones (marked Z5).

In the lighter zone (ZC), it seems that the soil surface is more degraded, due to trampling, ranging and cutting, than in the darker zone (ZS). Marked wind deflation has resulted, because the soil is less protected by vegetation, with stripping of the humiferous A Horizon from the surface. This gives the zone a lighter color than the other zone, which is darker because of better preserved humus.

This phenomenon must have been considerable, if we judge by the marked contrast between the coloration of the two zones.

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Near the town, three perimeters appeared relatively wooded in ~1954 (Perimeters marked 1), with low vegetation corresponding to newly planted trees. In 1980, these same perimeters appear much lighter than in 1954; there remains practically nothing of the former vegetation cover.

In 1980, a grayish zone is observed in the goud, which corresponds to a rewooded zone not visible in 1954. This is a densely planted wood of large Acacia raddiana. This zone, in the heart of the town, is protected and supervised by the administration, and thus is spared cutting. This wood is an example of the fact that vegetation can prosper in certain zones such as gouds (interdune depressions) where it finds more favorable humidity conditions, if it is spared the destructive actions of man.

Case of Tin-Yera Classified Forest and Rewooded Perimeter of Mederdra

The classified forest of Tin-Yera was created by classification decree 3519/SE/F on 11/21/45, as a "gum tree grove", Acacia senegal being the dominant, and almost only tree. In 1945, the classified forest covered a surface area of 1100 hectares. On the 1954 aerial photograph, the forest site appears darker than at present, with fairly dense trees. At that time, one could even see a perimeter within the forest, to the northest of Mederdra (see sketch) which appeared very wooded, of very dark color. Today there remains absolutely nothing.

The Tin-Yera classified forest appears the same as the surrounding desolate landscape. The gum trees have been demolished (as observed by a RAMS field trip) by intense cutting and drying and the presence of numerous nomade camps.

The rewooded Mederdra perimeter, located to the south of the town, was created by decree No. 1492/SE/F... It was also a gum tree grove. At present, there remains practically nothing of this perimeter, which blends with the meager surrounding vegetation. It has been invaded by Balanites aegyptiaca and Acacia raddiana, a sign of degradation.

These two examples illustrate the amplitude of degradation of the vegetation cover between 1954 and 1980.

B. Boutilimit (see Figure 10)

A geomorphological summary sketch was prepared based on the following 1/50,000 scale aerial photographs:

- AOF Mission 093 IGN (1954), and
- OMVS - Teledyne Geotronics (2/8/1980).

The surface area covered by the sketch is about 96 km2 (scale: 1/50,000). The town of Boutilimit existed well before Independance; it is a former colonial post, where the Circle Commander was based.

Urban Growth

The population of Boutilimit went from 2,774 inhabitants in 1961-62 to 7,261 inhabitants on Jan. 1, 1977 (Census Bureau, IRM, 1977), or a

LEGEND: BOUTILIMIT (1954-1979)

Figure 10

Town:

Extent in 1954

Extent on December 27, 1979

Live dunes:

Extent in 1954

Extent on December 27, 1979

Live dunes on dune crests in 1979
- Nonexistant in 1954

Present paved road

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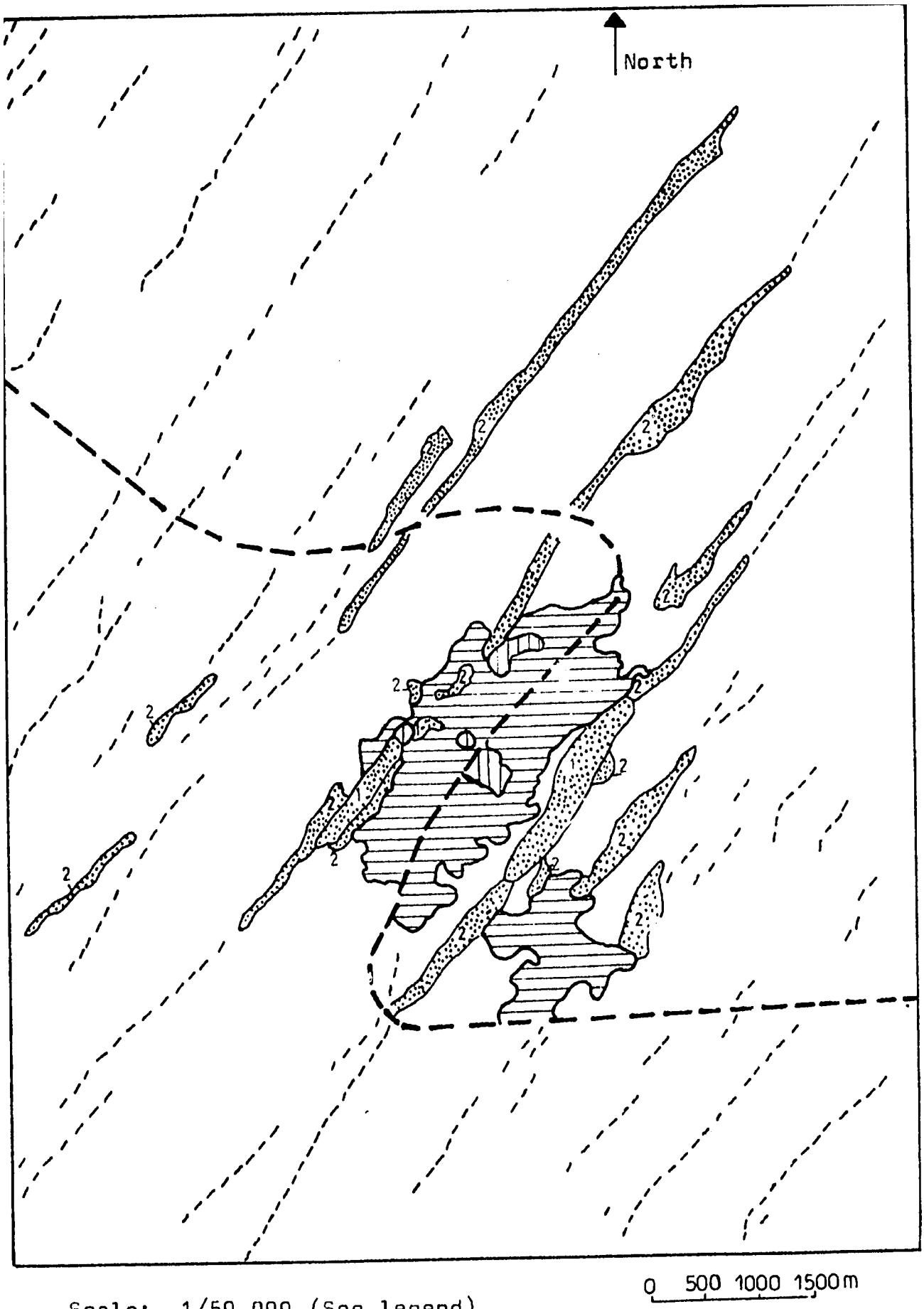
BOUTILIMIT 1954-1979



Scale: 1/50,000 (See legend)

Source: Author (RAMS, 1980)

Study based on aerial photographs IGN 1954 and OMVS 2/8/80 (Teledyne Geotronics).

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growth rate of more than 161.8%. This is considerable growth for a town located in a particularly fragile dune environment. Since 1977, the population has continued to increase.

Aerial photographs clearly show the prodigeous extension of the town between 1954 and 1980. On the sketch, the vertical hatching corresponds to the 1954 town limits, and the horizontal hatching to the present extension of Boutilimit. The extension zone contains mostly tents and huts around the former 1954 center, attesting to the extent of sedentarization affecting the Trarza region due to rural exodus caused by drought.

Shifting Dunes

In 1954, there were already two shifting dunes (Marked 1), to the east and west of the town. Since the considerable dune remobilization has occured, correlated to the extension of the town. This vast remobilization of dunes which were formerly fixed affects especially the dune crests (revoir, svp.). In the immediate surroundings of the town, large surfaces are affected by remobilized dunes (marked 2).

Causes

The town is located in a region receiving an annual average rainfall of about 200 mm; its geomorphology is that of the Trarza sand dunes.

The heavy concentration of population in this fairly fragile physical milieu has provoked more or less generalized remobilization of sands which were formerly fixed by vegetation. The process is well known:

Intensive wood-cutting to satisfy populations' needs, over-grazing, trampling of dune slopes by man and animals.

In addition, the construction of a paved road, according to a FAO report published in 1976 26/, caused the sand to "lose all cohesion practically from the point where the paved road crosses the dune, that is, about 1.5 km from the road and over a width of 100 to 400 meters".

Comparison of aerial photographs from 1954 and 1980 show that vegetable cover has thinned considerably. The soil appears darker in 1954 than today; wind deflation is certainly responsible for this color change, the superficial humiferous A Horizon having been stripped away.

C. Aleg (see Figure 11)

A geomorphological summary sketch was prepared from the following aerial photographs (scale: 1/50,000):

- AOF Mission 094 - 1954
- OMVS - Teledyne Geotronics 12/31/79.

The surface area covered by the sketch is approximately 95 km2. The town of Aleg was created by the colonial administration in 1904.

26/ M. Guigonis, "Rapport de Mission d'Evaluation du Projet Forestier au Sénégal et Identification de Projets Forestiers en Mauritanie", FAO-Rome, December 1976.

LEGEND: Map of Aleg 1954-1979 Figure 11

Town in 1954

Town on December 31, 1979

Lake of Aleg

Wadi

Lake of Aleg zone perimeter

A : Part of the lake with few major apparent changes since 1954

A_1 : Former sections of the lake, silted up since 1954

A_2 : Area with a very dense tree-like hydrographic network in 1980 typical of clayey depressions, with shrinkage fissure

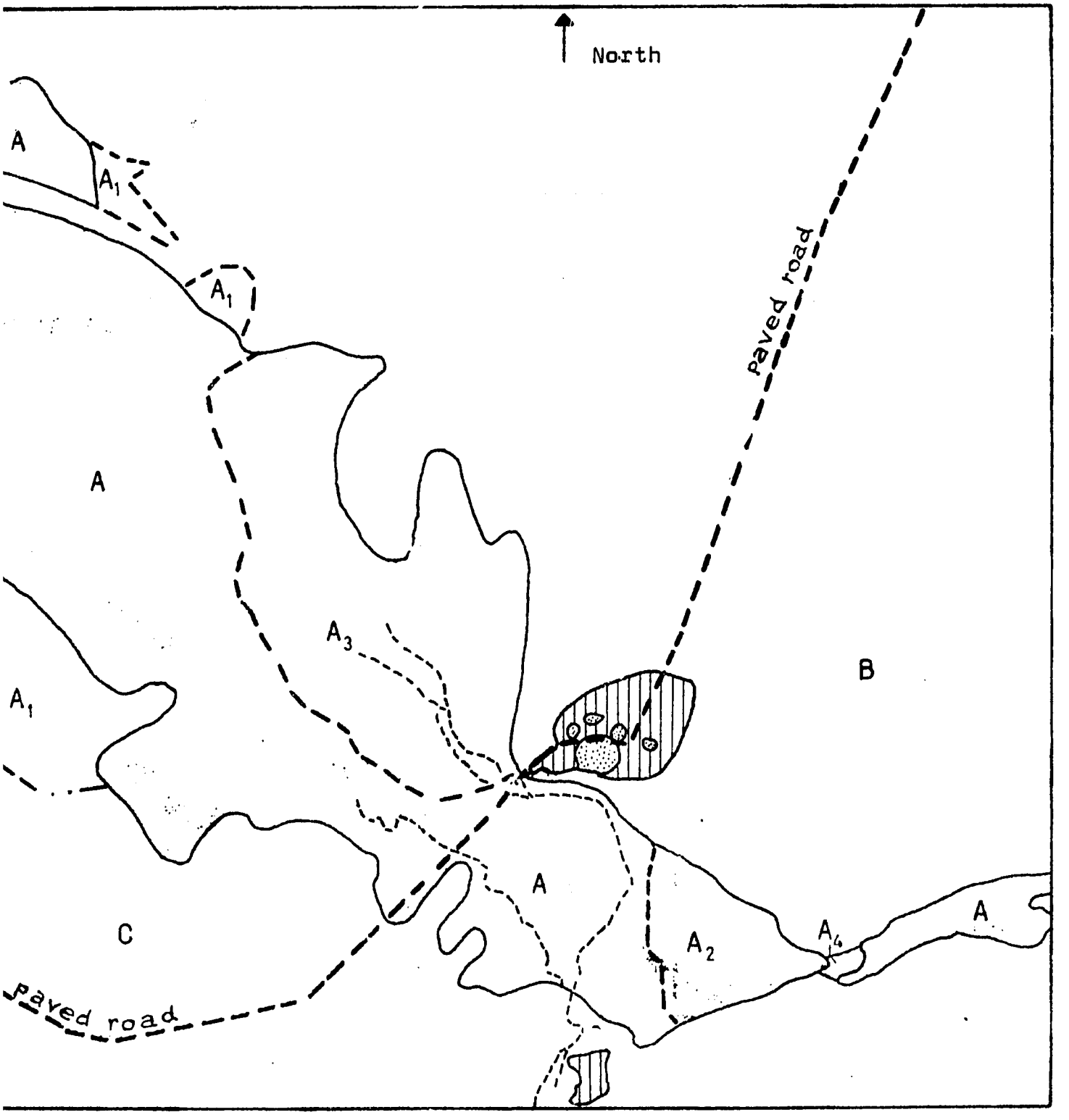
A_3 : Zone of A_2-type structure in 1954; A2 structure having vanished on OMVS photo 12/31/79

A_4 : Silted-up area of temporary water flows

B : Rag zones with ferricrust relief

C : Fairly well-wooded area in 1954 now with few trees

ALEG 1954-1980 Figure 11



cale: 1/50,000 (See legend)
ource: Author (RAMS, 1980)
tudy based on aerial photographs:
GN 1954 and OMVS 12/31/1979 (Teledyne Geotronics)

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Urban Growth

The population of Aleg went from 1,360 inhabitants in 1961-62 to 6,415 inhabitants in January, 1977 (Census Bureau, IRM, 1977), or a growth rate of more than 371.7%. Since the last census in 1977, the population has considerably increased. Aerial photographs markedly show this population growth between 1954 and 1979. On the geomorphological sketch, the vertical hatching corresponds to the present expansion of Aleg and the dotted zones to urban islets in 1954. The present extension zone of the town corresponds mainly to "banco" constructions, without nomad tents.

Geographical Location

The town is located on the southeastern border of the Aleg Lake. The old town is built on an indurated butte, with slopes littered by large ferrugineous rocks coming from the breakdown on the cuirass summit.

Three major geomorphological units are found around the town:

- the clayey-silty-sandy surface of the Aleg Lake, to the east of the town (marked A on the sketch)
- the rag zone, scattered with low reliefs of ferrugineous cuirass (marked B)
- a zone of sandy plains or dunes, alternating with rag surfaces (marked C).

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Desertification

The average rainfall in the Aleg region is 264.1 mm. Before the drought, the lake deserved its name, as it filled during the rainy season. Since the drought, only certain low areas are flooded.

We will examine successively, by geomorphological unit, the desertification process observed in the aerial photographs.

The Aleg Lake

In 1954, the Aleg Lake appeared much darker than today, with a clear-cut and complex hydrographic network. On Dec. 31, 1979, the color is paler and the picture of the lake is blurred by a white veil. During a RAMS field survey, we observed the presence of small sand covers on the dried lake surface. The local populations say these covers are a recent manifestation of the drought.

On the 1979 photographs, one can see a zone (A2) possessing a very pronounced dendrite structure. The A2 type zone was found in 1954 in the zone marked A3, to the north of Aleg. The aspect of this vast zone (A3) has totally changed; it is now smooth and the dendrite structure has completely disappeared, invaded by sand cover.

Zones marked A1 are former extension zones of Lake Aleg, which were visible in 1954 photographs and which have disappeared on the 1980 documents. The zone marked A4 concerns a temporary runoff zone linking two parts of the lake, which would seem, according to the photographs, to be invaded by sand. The hydrographic network of the lake appeared more dense and clear in 1954.

Vegetation

In 1954, there was considerable vegetation along the major oueds of Lake Aleg in the southern part. This "riverine" vegetation has almost totally disappeared on the 1979 photographs.

Rag Zone with Ferrugineous Indurations (B)

The soil surface and ferrugineous indurations appear clearly on the 1954 photographs. In 1979, the soil surface and reliefs 27/ seem drowned under almost generalized sand covers. White striations oriented from east to west underline the direction of the dominant wind-carrying sands.

This zone (B) was already only slightly wooded in 1954; it now has very meager vegetation (Boscia senegalensis, according to the 1979 field observations).

Zone of Sandy Plains and Dunes Alternating with Rag Surfaces (C)

This zone is very light in color in 1979 photographs, but was darker in 1954. This may be due to wind deflation having stripped the humiferous superficial horizon, or to greater soil humidity in 1954, or both. As to vegetation, the 1954 photographs show greater tree density than in 1979.

27/ Aerial photographs of 1979 are rather blurred, probably due to sand winds. Therefore, we cannot be categoric.

Thus, for the three geomorphological units studied, we note that there is rarefication of vegetation cover and sand invasion.

Note: Around the town of Aleg, a circular degradation zone was noted in 1954. In 1979, this zone was occupied by urban extension. The poor quality of the 1979 photographs does not permit identification of an existing "degradation circle".

D. Selibali (see figure 12)

A geomorphological summary sketch was prepared based on the following aerial photographs (scale 1/50,000):

- AOF Mission 058, Feb. 20-22, 1953
- OMVS - Teledyne Geotronics, Feb. 12, 1980

The surface area covered by the geomorphological sketch is about 99 km2 (scale 1:50,000).

The town dates from well before Independance. Like Aleg, Mederdra and Boutilimit, it is a former colonial post, where the Circle Commander was based.

Urban Growth

Urban population increased from 2,737 inhabitants in 1961-62 to 5,994 inhabitants in January, 1977 (Census Bureau, IRM, 1977), or a growth rate of 119%.

Comparison of aerial photographs shows that the growth of the town extends from the former center (vertical hatching) in two directions:

LEGEND: Map of Selibaby 1952/53-1980

Figure 12

Town in 1952-1953

Town on February 12,1980

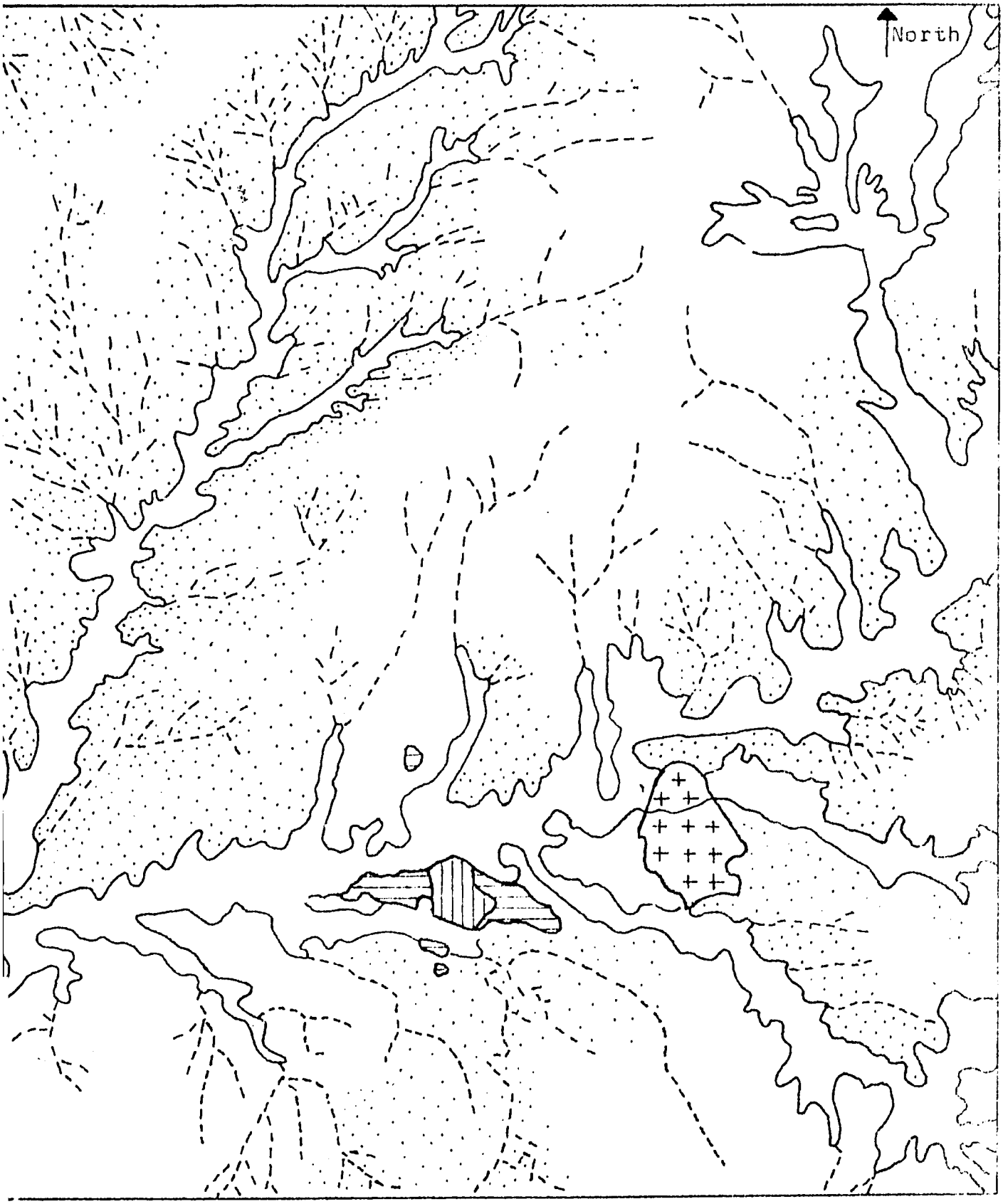
Wide alluvial zones of wadis

Wadis

Zone with marked sand covers - not visible in 1952-1953

Intensely cultivated area in 1952-1953 - not visible on February 12, 1980

SELIBABY 1952-53 to 1980 Figure 12



Scale: 1/50,000 (See legend)

Source: author, (RAMS, 1980)

Study based on aerial photographs IGN 1952-53 and ORVS 2/12/1980 (Teledyne Geotronics).

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east and west. This is due to the configuration of the surrounding physical milieu: to the north and south, the town is bordered by two large alluvial oued valleys, which are flooded during the rainy season.

Geographical Location

Sélibali is located in the heart of the Guidimaka, in the prolongation of the metamorphic Mauritanides Arc. It is built on a sandy interfluve, in the middle of a clayey-sandy plain dotted with inselbergs and cut through by a fairly dense network of oueds, which flood wide alluvial plains where floodland cultivation is practiced.

Sélibali is also in the center of the rainfed cultivation agro-ecological zone, with an average annual rainfall of a little more than 600 mm (for the period 1941-L970).

Two major types of geomorphological units are found, often overlapping:

- Oued alluvial valleys (in gray on the sketch)
- Clayey-sandy interfluve plains, dotted with inselbergs.

Desertification

Desertification is much less evident in this region than in more northern areas receiving less than 300 mm rainfall. However, the comparative examination of aerial photographs shows that the environment has been degraded since 1953.

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Hydrographic Network

In 1953, it is not very marked on the landscape. However, in 1980, the hydrographic network appears more sharply and is considerably darker. A possible explanation is that vegetation having thinned, there were less barriers to surface runoff. The increased speed of surface runoff may have limited infiltration (formerly favorized by vegetation cover and soil humis). The runoff channels thus become progressively gulleyed.

The darker tone of the hydrographic network in the 1980 photographs shows the baring of the inferior horizons of the soil or of the subjacent darker rock (?). In correlation with the increased gulleying of oueds, sand invasions are found, especially along the edges of oueds. A possible explanation is that the oued banks have been excessively trampled by animals in search of fodders (straws and legumes) which survive the dry season better in depressions. The trees along the oueds also attract not only livestock, but humans in search of wood.

This continual movement degrades the soil by destroying vegetation. This area sees heavy concentrations of livestock during the dry season, migrating from the northern zones (Tagant) in search of pasture.

It should also be noted that numerous oglats have been dug in the oued depressions, provoking large concentrations of animals come to drink.

All these factors lead to remobilization of sands which were often previously fixed in this oued region.

According to the questionnaire, sand winds have increased in the region since the drought began, depositing sand covers almost everywhere.

Rainfed Cultivation

Rainfed cultivation was more intensively practiced in this region before the drought. The rainfall deficit of recent years has made it increasingly risky.

Clearing for cultivation (both past and present) probably has played an important part in the desertification process described above.

The 1953 aerial photographs show, to the east of the town, a vast zone of intensive cultivation, well-defined on the landscape (see zone with crosses on sketch). This zone has totally disappeared on 1980 photographs. There are no other intensive diéri cultivation zones on the 1980 documents. However, traces of intensive floodland cultivation in the oued alluvial valleys around Sélibali can be seen.

Other Indicators of Desertification

Tracks and paths: Sharply demarkated on the 1953 aerial photographs, they appear somewhat "erased" on the 1980 photographs, as they are masked by sand covers.

Vegetation : Tree density appears less in 1980, attesting to thinning of vegetation since 1953.

The vegetation cover appears very sparse along the oueds as compared to 1953, probably due to animal and human actions as described above.

Only the inselberg (rocky relief) slopes still carry fairly dense vegetation, as their abruptness renders them less accessible to populations in search of wood and animals in search of fodder.

3.4.5. SUMMARY OF RESULTS

It is clearly apparent from the observations that human and animal activities around towns and villages (cutting, clearing, cultivation, pasturage) are profoundly destructive of vegetation cover and progressively denude the soil surface, with resulting: dune encroachment, sand covers, increase in velocity of winds carrying sand and dust, wind deflation, water erosion on certain surfaces (Aftout, edge of Senegal river), induration of soil surface.

Table 16 summarizes the main information for each town and village studied. It shows:

- location by latitude, by groups of one degree between 19° and 14° latitude north (Column 1)
- average rainfall (Column 2)
- population (as of 1/1/77) (Column 3)
- Main activities: livestock or agriculture (diéri, palm trees, vegetables, basin, oued floodland, oualo, irrigated) (Column 4)
- geomorphological data (Column 5)
- nature of soil degradacion (Column 6)
- qualitative estimate of degradation of vegetation cover (Column 7)

This table shows that in all the agro-ecological zones concerned by our study:

- the Senegal River Valley
- the rainfed cultivation zone
- the oued floodland cultivation zone
- palm grove zone
- pastoral zone

and no matter what the size of the town or village studied, there are major problems of environmental degradation.

- The most fragile milieus are the dune milieus, which cannot tolerate heavy sedentarization. Sands rapidly remobilize and may menace the physical existance of the town itself, in addition to the harmful consequences for existing of potential agricultural activities. Often, sand invades and seals off wells, which are essential for the population. and their livestock.

- other milieus, rags, for example, are not as menaced by massive sand encroachment (sand covers, often coming from other regions, are still minor).

- However, woodey and herbaceous vegetation are not able to reimplant on surfaces that are indurated or in the process of induration; on a long term basis, this is harmful for pasturage and firewood supplies for the sedentary populations.

Gulleying is usually localized in the Aftout zones and does not appear to affect human activities, given the current sparse rainfall. However, in the future, more abundant rains may fall on these particularly denuded surfaces, causing deeper gulleying, tearing up the meager vegetation and carrying off those arable soils which have been preserved until now.

3.4.5.1 Natural Regeneration of Vegetation around Towns and Villages

Table 17 gives the list and location of woody spcies observed to be in the process of regenerating around towns and villages. For 23 species, young plants were observed (0.50 cm to 1 Meter in height). However, it should be noted that the number of regenerating plants observed was extremely small. This table indicates only their presence.

Often, only a few young plants are observed, located far from the towns (at least one kilometer) and always outside the marked degradation zones. The presence of these young plants does indicate, however, that natural regeneration is possible even junder the current drought conditions; the small number of regenerating plants appears to be due mainly to sedentary livestock, which prevents their multiplication through grazing and trampling.

It is probable that efficient protection of these plants, by placing the ranges near towns and villages off bounds to humans and livestock, would, over a period of time, favorize natural regeneration of woody species and even herbaceous plants (grains and legumes).

TABLE 16

Towns, Villages and latitudes (1)	Rainfall (average mm) (2)	Population (1/1/1977) (3)	Main Activities (4)	Geomorphology (5)	Degradation (6)	Degradation of Vegetation Cover Observed (7)
Between 19° and 18°						
23 Tidjikja	142.3	7,326	1.Livestock 2.Palm groves, Vegetables	Tagant Large sands, valley and oued	Remobilized dunes	Great
22 Aghlambit	± same as Tidjikja	773	1.Livestock 2.Basin cult. and palms	Tagant - rocky and sandy	"	"
Between 17° and 14°						
1-0. Naga	between 150-200	830	1.Livestock	Trarza dunes	" bilisées	Very great
2.Ain Salama	± 200	1,192	1.Livestock 2.Vegetable cultivation	Trarza dunes	"	Very great
3.Bareina	± 250	1,128	1.Livestock	Trarza dunes	"	Great
8.Tiguent	± 150	808	1.Livestock 2.Veg.cult	Trarza dunes	"	Great
9.Aleg	264.1	5,185	1.Cult. (dieri, basin, veget.) 2.Livestock	Aftout rag	Sand covers	Great
10.Bou Chbeira	± same as Aleg	376	1.Livestock	Brakna dunes	Remobilized dunes	Very great
11.Choggar	± as Aleg	1,184	1.Livestock 2.Floodland culture	Contact of rags with dunes	"	Very great
12.Dionaba	300	957	1.Floodland cult. 2.Livestock	Aftout dunes	" and gulleys	great

TABLE 16 (CONT.)

Towns, Villages and Latitudes Between 17° and 18°	Rainfall (average mm)	Population (1/1/1977)	Main Activities	Geomorphology	Soil Degradation	Degradation of Vegetation Cover Observed
20. Moudjeria	255.9	1,935	1.Livestock 2.Palm cult. + vegetable	Tagant Piedmont, sandstone + sands	Remobilized dunes	Very great
21. M'Beika	± same as	1,010	1.Livestock 2.Floodland cult + vegetables	Tagant valley, alluvion deposits rocks + sand	"	Great
24. Boumdeid	250 mm	662	1.Floodland cult. 2.Livestock	Sandy plains	"	Very great
31. Tamchakett	264.9 mm	937	1.Livestock 2.Floodland cult.	Edge of Affolé rocks + sand	"	"
37. Oualata	± 200 mm	1,059	1.Livestock Floodland culture	Dhar Piedmont sandstone + sand	"	"

TABLE 16 (Cont.)

Towns, Villages and Latitudes	Rainfall (average mm)	Population (1/1/1977)	Main Activities	Geomorphology	Soil Degradation	Degradation Vegetation Cover Observed
Between 16° and 17°						
4.R'Kiz	± 250	1,744	1.Cultivation (diéri, walo) 2.Livestock	Trarza dunes contact with Clayey Lake	Sand Cover	Great
5.Mederdra	± 250	3,080	1.Livestock 2.Cult.(diéri)	Trarza dunes	Remobilized dunes	Very great
6.Rosso	310	6,178	1.Cultivation (diéri, Walo irrigated) 2.Livestock	Alluvial valley of Senegal	Water erosion paving of soil	Very great
7.Keur Macène	± 300	1,292	1.Cultivation (diéri, vegetables), 2.Livestock	River valley	Remobilized dunes	Small
13.Bababé	± 400	3,243	1.Cultivation (diéri, walo, irrigated) 2.Livestock	"	Interise clearing for cultivation, sand-covers	Very great
14.Kaédi	409.9	20,221	1.Cultivation (diéri,walo, irrigated)	"	Sand covers	Great

TABLE 16 (Cont.)

Towns, villages and Latitudes	Rainfall (average mm)	Population (1/1/1977)	Main Activities	Geomorphology	Soil Degradation	Degradation Vegetation Cover Observed
15. M'Bout	427	3,208	1. Livestock 2. Cultivation (diéri, walo)	Aftout rag	Some sand-covers	Very great
28. Laouessi	± 400	975	1. Cultivation (diéri) 2. Livestock	"	No marked degradation	Great
29. Barkewol	± 400	2,012	1. Cultivation (diéri, flood-land, irrigated vegetables) 2. Livestock	"	Sand covers	Great
30. Ghabra	± 400	1,467	1. Livestock 2. Cultivation (diéri, flood-land)	"	Water erosion sand covers	Very great
32. Aïoun	283	5,245	1. Livestock 2. Cultivation (diéri, walo)	Affolé sandstone	Remobilized dunes	Great
35. Timbedra	± 350	5,104	1. Livestock 2. Cultivation (irrigated diéri)	Sandy plain	"	Very great
36. Nema	315	7,577	1. Livestock 2. Cultivation (diéri)	Dhar-sand stone colluvions	Sand covers	Very great

TABLE 16 (Cont.)

Towns, Villages and Latitudes	Rainfall (average mm)	Population (1/1/1977)	Main Activities	Geomorphology	Soil Degradation	Degradation Vegetation Cover Observed
between 15° and 16°						
16. Maghama	± 600	4,486	1. Cultivation (diéri)walo) 2. Livestock	River Valley	Many sand covers particularly in cultivation zones	Very great
17. Sélibabi	649	5,872	1. Cultivation (diéri-basins) 2. Livestock	Clayey-sandy-stoney plain with inselbergs	Sand covers in cultivation zones	Great
18. Ould Yenge	± 550	1,324	1. Livestock 2. Cultivation (diéri-walo)	Karakoro dunes	Fixed dunes Light sand covers	Small
25. Kiffa	350,7	9,653	1. Cultivation (diéri-basins) 2. Livestock	Sandy plain	Remobilized dunes	Great
26. Kankossa	457	1,620	1. Cultivation (diéri) 2. Livestock	Karakoro dunes	Remobilized dunes	Great
27. Ain Teiss	± 500	295	1. Cultivation (diéri) 2. Livestock	Affolé sandstones	Slight sand covers	Small
33. Koboni	± 450	1,206	1. Cultivation (diéri) 2. Livestock	Sandy plain	Remobilized dunes	Great

TABLE 16 (CONT.)

Towns, villages and Latitude	Rainfall (average mm)	Population (1/1/1977)	Main Activities	Geomorphology	Soil Degradation	Degradation Vegetation Cover Observed
34. Touil	± 450	681	1.Cultivation (diéri) 2.Livestock	Clayey-sandy plain	Sand covers	Very great
38.Bassikounou	± 350	1,785	1.Cultivation (diéri) 2.Livestock	"	Sand covers	Small
39.Abdel Bagrou	± 450	2,177	1.Cultivation (diéri) 2.Livestock	"	"	Great
40.Bousteïla	± 450	1,099	1.Cultivation (diéri) 2.Livestock	"	Sand covers and gulleys	Very great
Between 14° and 15°						
19.Gouraye (Bakel)	712	554	1.Cultivation (diéri + Walo) 2.Livestock	River valley	Sand covers	Great

TABLE 17: WOODY SPECIES WHICH ARE REGENERATING (0.50 to 1 M) - LOCATION AND FREQUENCY (SEE TRANSECT SHEETS FOR TOWNS AND VILLAGES IN ANNEX).

SPECIES	TOWN AND VILLAGE NUMBERS	FREQUENCY (COMPARED TO OBSERVATIONS OF REGENERATING SPECIES)
Capparis decidua	1-2-4-9-12-13-22-24-28-29-30	5.2
Acacia senegal	1-3-4-5-8-16-17-18-26-27-28 29-32-33-34-35-38-39-40	9.0
Balanites aegyptieca	1-3-4-5-6-7-8-10-11-12-13 14-15-16-17-18-20-21-22-23-24-25-26-27-28-29-30-31-32-33-34-35-36-37-38-39-40	17.6
Acacia raddiana	2-4-5-8-10-14-20-21-22-23-24-25-26-31-32-35-36-37-38-39-	9.5
Maerua crassifolia	2-8-10-11-20-22-23-24-25-31 32-36-37-38	6.6
Zizyphus mauritiana	4-12-14-17-25-26-27-28-29 30-32-34-39-40	6.6
Tamarix aphylla	6-7	0.9
Acacia Albida	6-7-33	1.4
Acacia seyal	6-12-19-22-28-33-35-36-39	4.2
Euphorbia balsamifera	7-22-23-24-32-37	2.8
Acacia nilotica	7-21-27-34-39-40	2.8
Boscia senegalensis	9-10-11-13-14-17-22-23-27-31-32-37-38	6.1
Commiphora africana	11-27-35	1.4

TABLE 17: (CONT.)

SPECIES	TOWN AND VILLAGE NUMBERS	FREQUENCY (COMPARED TO OBSERVATIONS OF REGENERATING SPECIES)
Acacia flava	12-14-15-20-22-25-28-29-30 31-32-36-37-38-39	7.1
Bauhinia rufenscens	14-17-28-29-30-32-33-34-39 40	4.7
Calothropis procera	15-22-23-25-26-28-29-32-33 35-40	5.2
Indigofera sp.	15	0.4
Combretum glutinosum	16-17-19-26-27-33-40	3.3
Bauhinia reticulata	17-19-27	1.4
Guiera senegalensis	27-34	0.9
Grewia bicolor	27-34	0.9
Adénium sp.	27	0.4
Ptérocarpus luscens	38	0.4
TOTAL: 23 species		TOTAL: 210 observations

3-5) STUDY OF THE ENVIRONMENT OF PASTORAL WELLS (See Figures 4 through 6, Annex I)

In Chapter 2-2, we discussed the basic criteria for the choice of the pastoral wells to be studied. Observation of the vegetation and the condition of the soil surface around pastoral wells permitted an evaluation of the impact of livestock concentrations on the surrounding environment.

We sought pastoral wells located far from villages and towns, in the middle of ranges; this was not always possible, as even in the Trarza, where there are a great number of pastoral wells, small villages have recently grown up around wells. In addition, many wells have been abandonned due to lack of pasturage for animals.

Due to the great amount of time devoted to the questionnaires and the study of the environment around 40 towns and villages, the classified forests and pasturelands, only 6 pastoral wells were selected for study:

Location and Name of Wells (see location map in the Annex)

Region	Well Name	Lat.	Longit.	Map Number	Type of Well
(06) Trarza	Djeghmajek	17°5	15°59	2	cemented
" "	Rach-Telly	16°57	15°59	3	cemented
" "	Boubacar	17°12	15°11	7	cemented
" "	N'Ghadage	17°52	15°2	8	cemented
(03) Assaba	Gaouyere	15°50	11°18	16	cemented
" "	Greiguel	16°25	12°19	21	oglats

3.5.1 Analysis of Field Observations

a) Djeghmajek:

This pastoral well is located in the southern part of the Trarza, 35 kilometers to the northwest of Mederdra, in the heart of a formerly fixed dune system (red ogolian dunes).

It is a cemented well, about 32 meters deep. At present it is used by nomad populations coming from nearby camps with their animals.

Traditional water-drawing methods are employed. A délou is attached to a long rope, which is pulled by animals (camels or donkeys). Well forks maintain a wood pulley. The well has a side drinking trough. This well and its equipment are typical of the Trarza region.

During our survey, we were not able to determine the animal load for this well. However, the condition of the vegetation cover and the soil are very good indicators as to the use of the well.

Soil Surface (See "Pastoral Well Transect" N° 2, Annex)

This well is located in a goud (interdune depression) of which the surface is sandy-clayey, of grey color. The bordering dunes (more or less oriented Southwest to Northeast) are composed of light ocre sands.

A degradation ring of about 100 meters wide surrounds this well. The soil is extremely trampled and compacted. The surrounding dunes are beginning to remobilize, presenting shifting sand facies.

Vegetation (See "Pastoral Well Transect" N° 2, Annex)

In the degradation ring, only a few large Balamites aegyptiaca, a few gum trees and one Acacia raddiana have survived, obviously spared because of the shade they provide during the hot hours of the day. Several standing withered Balinites were observed.

Beyond the degradation ring, the density and frequency of trees increases and rapidly stabilizes over a few hundred meters.

Acacia raddiana is dominant (about 50% of observations), followed by Balanites aegyptiaca and Acacia senegal.

The average spacing between trees varies from 1 to 5 meters; this is relatively prosperous vegetation compared to other pastures observed in the Trarza. The presence of young trees (about 50 cm high) for all species shows the satisfactory condition of this pasture, which is in the process of natural regeneration.

Also noted on the soil surface were a few tufts of Panicum turgidum ("Markba" in Moor), a grass.

Traces of former clearing for cultivation were observed; dilapidated zeribas still fence rainfed cultivation zones which have been abandonned since the drought. These numerous zeribas indicate intense clearing in the past.

Wind deflation has exposed the roots of many Balanites aegyptiaca on the dunes and their slopes. When the base of the tree is exposed, the

tree falls. This phenomenon is more rarely observed in the gouds, due to topographical location and more compact soils.

In general, the vegetation is more degraded on the dunes and relatively better preserved in the depressions.

Summary of Condition

Degradation of the vegetation cover is severe in the immediate surroundings of the well, but decreases rapidly after a few hundred meters. This indicates a fairly low pastoral load around the Djeghmajek well. However, wind deflation is fairly intense, if we judge by the great number of Balanites aegyptiaca which have fallen.

A few rare traces of recent cutting were also observed.

b) Rach Telly

This well is located in the south of the Trarza, about 30 km north of Rosso, in the ogolian dune belts.

The presence of an abandonned cemented well shows that this site has been used for watering in the past. The new cemented well was recently built by a local tribe (the Zenbetty) and was put into operation on 4/4/68. A very small village (Bounkheila) has grown up around the well.

This well is about 10 meters deep: fresh water supplies are sufficient. Traditional water-drawing methods are employed, as described for the preceding well.

The animal load was not heavy during our visit to the well on 5/23/80, as

most of the livestock had migrated to the Senegal River Valley in search of pasture.

Soil Surface (See Pastoral Well Transect Sheet N° 3, Annex)

This well is located in a large goud, about 600 meters wide, which is composed of gray, clayey-sandy soil and bordered by two large fixed dunes, oriented approximately northeast to southwest.

To the north of the well, a vast degeneration zone was observed over about 500 meters. To the south, the degradation zone covers about 1 000 meters. The degradation ring is thus asymetric and characterized by intense trampling and a great number of dried excrements.

Vegetation

In the degradation ring, there are only a few trees, spaced on an average of every 30 meters; the following species were observed: Balanites aegyptiaca, which attains a height of about 5 meters; in poor condition (mutilation).

Leptadenia spartium of about 50 cm high.

A lone Tamarindus indica of about 10 meters high was observed; its presence provides ample shade during the hot hours.

Beyond the degradation ring, the density and frequency of species increases over a few hundred meters and then stabilizes. To the south of the well, we observed Acacia senegal (dominant, about 50% of observations), as well as Acacia seyal, Balanites aegyptiaca, Acacia raddiana,

Tamarindus indica and Calothropis procera. The presence of a few young (about 50 cm high) Balanites aegyptiaca, Acacia raddiana and Acacia seyal indicates a certain degree of natural regeneration.

Straw was noted on sandy areas of the soil surface. These are the remains of Cenchrus biflorus, but are not abundant (coverage less than 10%).

To the north of the well and the degradation ring, about the same plant distribution is encountered.

Traces of old zeribas show that agricultural activities were practiced before the drought, but they have totally disappeared since.

Summary of Condition

The vegetation cover is severely degraded over 500 to 1 000 meters around the well. Beyond this distance, vegetation cover is in relatively good condition, little wind erosion was observed, as well as little cutting or over-grazing.

c) Boubacar

This pastoral well is located in the southeast of the Trarza dune region, 7 km to the northeast of Bareina (Observation Town N° 3) and about 40 km north of R'Kiz (Observation Town N° 4). It is a cemented well, about 52 meters deep, dug 27 years ago.

About 2 years ago, a few nomads sedentarized and built a village near this well (as frequently happens in the Trarza due to the persistent drought).

Water drawing methods are traditional, as previously described. As for the other wells (Rach Telly and Djeghmajek), this well is used by all types of livestock (goats (dominant), sheep, camels, donkeys and cattle). The animal load was not heavy during our visit (5/18/80), as most livestock has migrated to the "Chemana", as usual during the dry season.

Soil Surface (See Pastoral Well Transect N° 7, Annex)

The well is located right in the middle of a 300 meter wide goud, flanked by two remobilizing dune belts. The dune system is oriented northeast to southwest. The bottom of the goud is invaded by sand covers from the dunes.

A totally barren degradation ring of sandy-clayey surface surrounds the well for about 200 to 300 meters. The soil is heavily trampled and littered with dried excrement. Mobile sands are present everywhere and dune crests are remobilized.

vegetation (See Pastoral Well Transect N° 7, Annex)

Within the degradation ring, there is no vegetation. Beyond the ring, plants progressively appear; their density and frequency increase as follows (in the goud):

- from 200 - 300 meters to 600 - 700 meters: Balanites aegyptiaca, 50 cm to 4 meters high, and Acacia raddiana, 50 cm to 3 meters high.
- from 600 - 700 meters to 1 mile and more: Acacia raddiana (dominant), Acacia senegal (50 cm to 3 meters), of which more than half are dead

due to withering, and Balanites aegyptiaca.

In certain zones, one sees veritable gum tree cementeries, where more than 80% of the trees are dead, fallen or shapeless debris.

The distance between living trees varies from 2 to 20 meters.

Outside the degradation zone, a little straw is found (coverage rate less than 5%). The presence of a few young Balanites aegyptiaca, Acacia senegal, and Acacia raddiana shows a modest amount of natural regeneration.

Summary of Condition

Vegetation is fairly degraded, especially Acacia senegal which was frequently found to be withered.

The withered gum trees fall and form piles of branches; these obstacles favorize accumulation of windborne sand and progressively constitute small mobile dunes, which could eventually become menacing.

The death of the Acacia senegal is not due to livestock. These trees were weakened by intensive bleeding for gum arabic, and were thus not able to withstand the drought.

d) N'Ghadage

This well is located in the heart of the Trarza, about 50 km from Boutilimit and 6 km south of the Nouakchott-Boutilimit road.

It is cemented, and of the same type as the previously cited pastoral wells. Dug about 18 years ago, it is about 60 meters deep and still in

good condition, providing adequate water supplies.

During our visit (5/15/80), three camps were seen in the well area, but very few animals were present, most having migrated in search of pasture to the Senegal River valley and to the edge of Lake R'Kiz in the south.

Soil Surface: (See Pastoral Well Transect N° 8, Annex)
This well is located in a goud about 500 meters wide, flanked by two remobilizing dune belts, with shifting crests. The dune system is oriented approximately northeast to southwest.

The bottom of the goud is grey and sandy-clayey near the well, and much more sandy elsewhere.

The degradation ring around the well covers 200 to 300 meters. The soil is trampled and littered with dried excrement.

Vegetation Cover (See Pastoral Well Transect N° 8, Annex)
Within the degradation ring, herbaceous cover is absent and no trees have been left for shade. A few extremely mutilated Maerua crassifolia ("Atyl" in Moor) were observed.

Outside the marked degradation ring around the well, other plants progessively appear: Commiphora africana, Balanites aegyptiaca, Leptadenia spartium, Acacia raddiana, Maerua crassifolia.

Commiphora africana: more than 50% of the plants were dead of withering on the dunes.

All the other trees are quite mutilated by cutting for wood and livestock fodder, as well as by over-grazing.

In the center of the goud (light gray in color), Maerua crassifolia is dominant. On the dunes and their sandy edges, Commiphora is dominant (about 80% of observations), associated with Acacia raddiana, Balanites aegyptiaca and Leptadenia spartium.

Summary of Condition

The vegetation cover and the soil are very degraded around the N'Ghadage well, due to intense cutting and over-grazing. However, it is evident that the drought has also played a large part in the death of Commiphora africana.

e) Gaouyere

This pastoral well is located about 30 km southeast of the town of Kankossa (Department of Kankossa, Administrative Region of Assaba), on a sandy plain on the western edge of the sandstone Affolé Massive.

It was dug by the Génie Rural in 1969. It is cemented and 5 meters deep. Water-drawing is manual, using the délou. The water comes from the Gaouyere oued alluvial aquifer, on the edge of which the well was dug.

A very small village is located several hundred meters southwest of the well (village of Gaouyere, identifiable in IGN Sheet ND-29-XIX Kankossa, scale 1/200,000, September 1969).

Soil Surface: (See Pastoral Well Transect Sheet N° 16, Annex)

The well is located on a sandy surface, fixed by woody cover. No visible traces of sand remobilization are found around the well; however, a slight degradation ring of about 50 meters was observed. The soil has been trampled by man and animals and is abundantly littered with dried excrement.

Vegetation Cover:

Vegetation cover is fairly dense. The average distance between woody species varies from 1 to 10 meters. The degradation ring is characterized by marked thinning of vegetation. It is almost exclusively populated by Calothropia procera and a few "doum palms" (Hyphaene thebaica). These plants are quite mutilated (cutting and ranging (Calothropis procera) and burnt (Hyphaene thebaica).

Hyphaene thebaica are fairly dense on the sandy banks of the Gaouyere oued. This tree attains up to 8 meters in height. Its presence indicates an alluvial aquifer near the surface, with plentiful water supplies. The dominant tree (except along the immediate edge of oueds) is Combretum glutinosum (50 to 60% of species represented), which are Calothropis procera, Sclerocarya Birrea, Adonsonia digitata (Baobab), Balanites aegyptiaca, Acacia senegal, Acacia raddiana, and Hyphaene thebaica. Most of these trees are large. Only a few Combretum were found to be withered. No herbaceous carpet was seen at the time of our visit.

Assessment:

The soil and the vegetation are fairly well preserved around the well of Gaouyere, outside of a small ring of deterioration. Cutting is infrequent and the presence of young Balamites aegyptica and Acacia senegal is indicative of a certain natural regeneration of these species.

f) Greiguel

In the Greiguel oued alluvial valley, there are 5 oglats (uncemented traditional wells). They are quite shallow (1 to 2 meters deep) and coffered with branches. They are located about 50 km northeast of MBout, in the Aftout, near the village of Greiguel. They are primarily used to water livestock (sheep, goats and cattle).

The water is fresh, but soiled by animal droppings and dirt which crumbles from the oglat sides.

During the RAMS visit on 6/21/80, most of the animals had migrated to the south.

Soil Surface (See Pastoral Well Transect N° 21, Annex)

A degradation ring of about 200 meters surrounds the oglat zone. The soil shows signs of heavy trampling and excrements. It is compact, clayey and brown.

Outside the oued bed, the soil is the clayey-sandy, light grey, gullied soil characteristic of the Aftout.

Vegetation Cover (See Pastoral Well Transect N° 21, Annex)

In the degradation ring, only a few widely spaced trees subsist: Zizyphus mauritiana, Acacia nilotica and Mytragina inermis; they have been mutilated by cutting.

After 200 meters, the vegetation cover becomes rapidly more dense and the number of species is greater, as follows:

Balanites aegyptiaca (dominant, about 30% of observations)

Acacia nilotica (about 20% of trees in certain sections)

followed by: Acacia flava, Boscia senegalensis, Zizyphus mauritiana, Acacia senegal, Bauhinia rufescens, Mytragina inermis, Capparis decidua, Acacia seyal, Calothropis procera, Tamarindus indica.

Besides the large and medium trees, young plants were observed (about 50 cm high), indicating natural regeneration.

Summary of Condition

Outside the degradation ring, soil and vegetation are relatively undegrated. The average distance between trees varies from 1 to 10 meters. Signs of cutting were found almost everywhere, either for firewood or livestock feed. Some Zizyphus mauritiana were withered. Herbaceous vegetation is totally absent.

3.5.2 Summary and Conclusions

All the pastoral wells studied present a fairly marked degradation ring, but of fairly modest size in most cases.

The effect of livestock on vegetation is less dramatic than might have been supposed. Outside the degradation zones immediately around the wells, the pasturelands regain their "normal" aspect; the woody vegetation is distributed in much the same manner as elsewhere far from pastoral wells and large concentrations of men and animals.

Around all the wells studied, modest natural regeneration was observed for certain species. It is probable that the pastoral wells have been much less frequented since the drought began, due to lack of herbaceous forage. Even during the rainy season, sufficient grass pastures may not develop, as the lack of straw during the dry season observations would seem to confirm.

TABLE 18

LIST OF WOODY SPECIES OBSERVED DURING TRANSECTS AROUND PASTORAL WELLS

WOODY SPECIES	FREQUENCY (FOR 48 OBSERVATIONS)
Acacia raddiana	10.4%
Acacia sénégal	12.4
Acacia flava	4.4
Acacia seyal	4.4
Acacia nilotica	4.4
Balanites aegyptiaca	15.5
Commiphora africana	2.2
Maerua crassifolia	2.2
Combretum glutinosum	4.4
Sclerocarya birréa	4.4
Hyphaene thébaïca	2.2
Adansonia digitata	4.4
Calothropis procera	8.9
Zizyphus mauritiana	4.4
Capparis decidua	4.4
Mytragina inermis	4.4
Bauhinia rufescens	2.2
Tamarindus indica	4.4
Leptadenia spartium	2.2
Acacia sénégalensis	2.2
(Total : 20 species)	(Total : 48 observations)

3-6) STUDY OF THE PASTORAL ENVIRONMENT (See Location Maps, Figures 4, 5, 6 in Annex)

The pasturelands (or ranges) selected for this study were considered representative of environmental conditions, as they are far from areas of human and animal concentrations such as towns, villages and wells. (See Chapter 2-3). Those zones not subjected to human and animal pressures permit the evaluation of natural regeneration of the environment when free of intensive cutting, over-grazing, trampling and other degradations due to the over-exploitation of limited resources.

19 pastures were visited in the southern third of Mauritania. The following list gives the tables based on field surveys:

Table 19 gives the locations of the pastures by region, as well as approximate annual rainfall for each site.

Table 20 gives information on the soils and geomorphology encountered during vegetation transects of pastures.

Table 21 furnishes the list of woody species encountered during the transects and frequency of species.

Table 22 gives a list of withered woody species encountered and their locations, in order to estimate the impact of drought on vegetation.

Table 23 summarizes the regeneration of woody species and their frequency for all the pastures studied.

Table 24 concerns the rate of herbaceous coverage, expressed as a percent.

Table 25 summarizes data about vegetation cover: cutting, zeribas, cultivation, straw, living grasses, withering of woody species, regeneration of woody species.

3.6.1 Analysis and Comparison of Data

The analysis and comparison of these different tables and of the transect sheets (see Annex) show certain interesting observations about the condition of the environment in the pastures studied.

1) Latitude and Rainfall

The pastures were distributed between approximately 15° and 19° latitude North and 7° and 16° longitude West. The following gives the pasture distribution by latitude:

- 1 pasture (N° 12) between 18° and 19° latitude
- 6 pastures (N° 1, 6, 9, 10, 11, 13) between 17° and 18° latitude
- 6 pastures (N° 4, 5, 14, 15, 23, 25) between 16° and 17° latitude
- 5 pastures (N° 16, 18, 19, 22, 24) between 15° and 16° latitude
- 1 pasture (N° 17) between 14° and 15° latitude.

Rainfall varies with the latitude, increasing from north to south (see Table 19).

- 4 pastures (N° 1, 9, 11, 12) receive an annual rainfall equal to or less than 200 mm.
- 7 pastures (N° 4, 5, 6, 10, 13, 14, 25) receive an annual rainfall between 200 mm and 300 mm.

- 3 pastures (N° 15, 20, 23) receive an annual rainfall between 300 and 450 mm.

- 5 pastures (N° 17, 18, 19, 22, 24) receive an annual rainfall between 450 and 650 mm.

Generally, rainfall goes from 150 mm in the north of the Tagant to 650 mm in the south of the Guidimaka.

The pasturelands are thus relatively equally distributed according to rainfall and latitude.

2. Soils and Geomorphology (See Table 20)

The pastures are distributed among the geomorphological units and soil most commonly found in the southern third of Mauritania:

- sandy domains (plains and dunes)
- rags and clayey-sandy plains
- sandstone massives (Tagant, Assaba, Dhar Néma)
- vast lowland zones (clayey soils)

- 9 pastures (N° 1, 4, 5, 6, 9, 14, 15, 19, 23) belong to the sandy domains.
- 4 pastures (N° 10, 17, 22, 24) belong to the rags and clayey-sandy plains
- 5 pastures (N° 1, 12, 13, 20, 25) belong to the sandstone massives (and their edges)
- 1 pasture (N° 8) belongs to the clayey lowlands (temporarily flooded)

3. Withered Woody Species Encountered (see Table 21)

Of a total of 22 woody species identified during the 19 "pasture" transects, 8 species were found to be withered, whether still standing or fallen, without any trace of mutilation. The most frequently withered species were Acacia senegal and Commiphora africana.

- Acacia senegal in the Trarza dune pastures and in one sand pasture north of Kiffa.
- Commiphora africana in one Trarza dune pasture and in 3 pastures on the Tagant plateau, in more or less sandy zones.

Most frequently, the gum trees were found to be withered between approximately 16°30 and 17°30, where the average annual rainfall is between 300 and 200 mm.

As for Commiphora africana, it was found to be more frequently withered in pastures located between 17° and 19° latitude, receiving an average annual rainfall between 250 and 150 mm. (This tree grows much farther north than the gum tree, which is rarely found above 17° latitude).

4. Death of the Gum Trees

In Trarza pastures (N° 4, 5, 6), 25% to 80% of the gum trees are dead. Between Kiffa and Boumdeid (pasture 14), almost all the gum trees have disappeared since the drought began. The hypothesis has been advanced that these trees, over-exploited by intensive bleeding for gum arabic, were too weakened to withstand the drought.

5. Disappearance of Commiphora africana

In Trarza pasture N° 9, about 80% of these trees had died of withering. In the Tagant pastures, about the same proportion of withered trees was observed.

It should be noted that outside the pastures selected for study and vegetation transects, we observed the same withering of gum trees and Commiphora africana under the corresponding latitudes and average rainfall distributions.

A map of gum tree distribution and degradation zones is discussed in Chapter 3-9, "General Summary of Observations".

The other species observed were found to have much less withering, regardless of latitude, rainfall, soil and geomorphological units. These species are:

Acacia flava, Acacia raddiana, Grewia bicolor, Combretum aculeatum, Balanites aegyptiaca, Euphorbia balsamifera.

Note: In the pastures studied, we found no withered Acacia nilotica. However, this tree has been greatly affected by the drought and a great number of Acacia nilotica have died of withering in the Senegal River valley, as will be discussed in Chapter 3-7, "State of Classified Forests".

Most withered species seem to be the victims of rainfall deficits. However, the advanced state of withering and crumbling of most of the

trees does not allow exclusion of past mutilations now impossible to detect (cutting, over-grazing, bleeding, etc.). Only those standing, recently dead trees, with no trace of mutilation, lead us to attribute the cause of withering to prolonged rainfall deficits.

6. Regeneration of Woody Species.

16 woody species (see Table 23) were observed to be regenerating, presenting young plants of less than 50 cm to one meter high. Most frequently observed to be regenerating was Balanites aegyptiaca (more than 20% of all cases observed in the survey pastures). Acacia senegal comes second with 15% of cases observed. Thus this tree, which has suffered a veritable hecatomb, is able to regenerate in certain areas, even in pastures where the largest Acacia senegal cementaries were identified (Pastures 4, 5 and 6 in the Trarza and 14 north of Kiffa).

Acacia raddiana (frequency: 9.58%) regenerates mainly in sandy soil

Acacia flava (frequency: 8.21%) regenerates mainly in the clayey-sandy soil of the Aftout rags.

Maerua crassifolia (frequency: 8.21%) regenerates in gouds and clayey-sandy depressions.

With the exception of Acacia seyal and Combretum glutinosum (in the south Guidimaka and southeast of the country), the other species were much less frequently observed to be regenerating.

It is interesting to note that the species most frequently undergoing

natural regeneration are also the most frequent species in the 19 pastures studied (see Table 23). However, for these 19 pastures, it should be stressed that the regeneration of woody species is still very modest, but may be considered an encouraging step towards progressive reconstitution of the vegetation carpet, if, in the future, human and animal pressures do not perturb the fragile process of natural regeneration.

The largest regenerations were observed in the fixed dune zones, such as in the Trarza, and particularly in interdune depressions (gouds) and their edges. In rag zones, regeneration is rarer, except in sand accumulations and on the edges of oued beds.

7. Herbaceous Cover

As the surveys were conducted at the end of the dry season, the herbaceous cover could not be studied. However, the USAID Renewable Resources Project will study the herbaceous carpet of the southern third of Mauritania, supplying the necessary data.

In addition, the observation of the condition of herbaceous cover at the end of the dry season is useful in that it shows the coverage of the soil surface which is presented during most of the year to harsh wind erosion, and before the first rainfalls, which are often violent and also provoke erosion (whether surface or gulleyed). Also, it is important to note that the herbaceous cover available for animal forage during the dry season is practically insignificant, forcing livestock (especially cattle) to migrate in search of straw to Mali or Senegal.

Table 24 shows that for the 19 "pastures" observed:

- 5 had absolutely no living grass or dried straw.
- 10 had insignificant coverage (less than or equal to 5%)
- 2 had slight coverage (more or less equal to 10%)
- 2 had appreciable coverage (around 20% for one and attaining 30% for the other).

Table 25 (Columns 6 and 7) furnishes data on the presence of living grasses and dried straw.

In 9 pastures, living grasses were observed, mainly Panicum turgidum, as well as Andropogon sp. in the south of the country.

In 9 pastures (of which three belong to the 9 above-cited pastures with living grasses), dried straw was observed on the ground, mainly Cenchrus biflorus (the notorious "cram-cram"). Other dried straws could not be identified.

3.6.2 Summary of Condition of Pastures

The 19 transects of aerial pastures (woody species) in the southern third of Mauritania shows the natural regeneration possibilities under ifferent latitudes, with the climatic and soil preferences of the different species. While deficient rainfall undoubtedly hinders normal growth and regeneration, it is not always the only cause of degradation, as demonstrated by Table 26, Columns 2, 3, 4 and 5:

- In 13 pastures out of 19, we observed signs of cutting, both recent and several years old.

- Zeribas were observed in 5 pastures, of which three were located in areas where average annual rainfall was about 300 mm before the drought (1941-70 average). These zeribas are no longer in use, but testify to former cultivation in these regions, which were once "pioneer fronts" of rainfed agriculture. Thus at some time before the drought, clearing for cultivation and fairly heavy animal concentrations existed in these areas.

In the southern pastures (Guidimaka), one can see numerous functional zeribas and much clearing for cultivation.

During the pastureland study, we were unable to determine the animal load, as most livestock had migrated to Mali or Senegal. Most pastures were deserted, due to lack of forage, especially in the southwest. In the southeast, in addition to lack of dry season pastures, there are relatively few permanent water holes.

In the north of the study zone, grass and woody pastures are quite meager due to the arid climate. In the center and south of the country, where the population and their livestock have migrated, past and present human and animal actions combined with the prolonged drought have lead to considerable degradation. It is often difficult to determine which is the main cause of degradation, as climatic and population pressures often work together.

Some exceptional large, green, dry-season pasturelands were observed, up to 18° latitude north. They deserve to be mentioned, as they were lare in surface area; they are the pastures of the Tamourt en Naaj and its tributary valleys in the Tagant, of the Lake Lebheir plain in the Assaba, and of the Senegal River valley in the Keur Macène region.

The Tamourt en Naaj is a large alluvial valley which cuts through the sandstone Tagant plateaus, at about 18° latitude north. Certain zones are flooded year-round, and the inferoflux is near the soil surface almost everywhere. This results in exceptionally green herbaceous vegetation in an otherwise grey, rocky or sandy environment.

In the Assaba, to the west of the Massive around 17° latitude north, a permanent lake can be found at the foot of the sandstone cliffs. The lake is fed by perennial springs and even in the heart of the dry season, the lakesides are carpeted with green grasses.

Around Keur Macène, near the Senegal River delta, immense green pastures are found. The grasses were mainly Andropogen sp., and other species we were not able to identify.

In all these pastures, we observed heavy livestock concentration:

- Sheep and goats were dominant in the Tamourt en Naaj, with a few cattle, donkeys and camels.
- cattle (Moor Zebus) were dominant at Lake Lebheir
- Cattle (Peul and Moor Zebus) and camels dominated at Keur Macène.

TABLE 19

Region	Pasture Number on map	Pasture name and Location	Average Rainfall (1)
(06) TRARZA	1	Between Boutilis & Tiguent	± 200
(06) "	4	Between Nouakchott & Rosso	250 - 300 mm
" "	5	South of Mederdra	250 - 300 mm
" "	6	Between Boutilimit & [illegible]derdra	200 - 250 mm
" "	9	Between Nouakchott & [illegible]utilimit	100 - 200 mm
([illegible]) [illegible]	10	Between Letfatar & Moudjeria	200 - 250 mm
" "	11	Between Moudjeria & N'Beika	150 - 200 mm
" "	12	Between Aghlambit & Nimelane	150 - 200 mm
(03) ASSABA	13	Between Ghoudia & Boumdeid	200 - 250 mm
" "	14	Between Boumdeid & Kiffa	250 - 300 mm
" "	15	To the East of Amredjel	300 - 350 mm
(10) GUIDIMAKA	17	Between Gouraye & Sélibabi	650 - 700 mm
" "	18	Between Sélibabi & Harr	600 - 650 mm
" "	19	Between Harr & Maghama	550 - 600 mm
(04) GORGOL	20	Between Soufa & the pase	400 - 450 mm
(02) HODH EL GHARBI	22	Between Touil & Aïn Farba	450 - 550 mm
" "	23	Between Aïoun & Timbédra	300 - 350 mm
(01) HODH EL GHARGUI	24	Between Bousteïla & Djiguéni	450 - 500 mm
" "	25	Between Oualata & Néma	250 - 300 mm

(1) Estimated on the basis of normal rainfall from 1941 to 1970.

TABLE 20 - PASTURES AND GEOMORPHOLOGICAL DATA

PASTURE NUMBER	CONDITION OF SOIL SURFACE	GEOMORPHOLOGY
1 Between Boutilis and Tiguent	more or less fixed sandy soil	Trarza Dunes
4 Between Nouakchott and Rosso	more or less heavy grayish clayey soil	" "
5 South of Mederdra	fixed sandy soil (Goud Heavily Sand-covered)	" "
6 Between Boutilimit and Mederdra	Sandy soil	" "
9 Between Nouakchott and Boutilimit	Sandy soil	" "
10 Between Letfatar and Moudjeria	Slighlty Stoney Clayey Soil	Aftout Rag
11 Between Moujeria and N'Beika	Sandy soil around oued - sandy - clayey Soil in oued bed - Sandstone rocks on edges	" "
12 Between Aghlambit and Nimelane	Clayey soil with sand cover Substratum: Tagant sandstone	" "
13 Between Koudia and Boumdeïd	Clayey soil with presence of sand cover and occasional rock outcrops (Tagant Sandstone	" "
14 Between Boumbeïd and Kiffa	more or less compact clayey soil in interdunes, fiwed in dunes	Sandy plain
15 East of Amredjel	Clayey - silty soil, brown, of the Amredjel oued valley	Sandy plain on edge of Affolé
17 Between Gouraye and Sélibabi	Sandy	Clayey-Sandy plain with inselbergs
18 Between Sélibabi and Harr	Sandy - Clayey soil	Vast low-land
19 Between Harr & Mahgama	Sandy	Sandy plain
20 Between Soufa and the Pass	Gulleys in sandy material with - Ferrugineous Gravel - sandstone blocks (Rocky substratum: Assaba sandstone)	Assaba Sandstone Massive
22 Between Touil and Aïn Farba	Clayey soil covered by sand	Clayey - Sandy Plain
23 Between Aïoun and Timbedra	Sandy soil on plain, clayey soil in Low-lands	Sandy Plain
24 Between Bouteïla and Djiguéni	Clayey soil covered by fixed sands	Clayey-Sandy Plain
25 Between Oualata and Néma	Clayey-sandy soil alternating with Rocky Terrain (Sandstone, Pellite)	Dhar Néma Piedmont

TABLE 21

WOODY SPECIES OBSERVED DURING "PASTURE" TRANSECTS

WOODY SPECIES	FREQUENCY (OUT OF 108 OBSERVATIONS)
Acacia sénégal	12.0
Acacia raddiana	8.3
Balanites aegyptiaca	14.8
Bauhinia rufescens	1.8
Maerua crassifolia	6.4
Acacia seyal	5.5
Zizyphus mauritiania	5.5
Commiphora africana	4.6
Capparis decidua	5.5
Acacia flava	6.4
Euphorbia balsamifera	2.7
Boscia sénégalensis	3.7
Salvadoria persica	1.8
Calothropis procera	1.8
Acacia nilotica	1.8
Combretum glutinosum	4.6
Sclerocarya birréa	3.7
Adansonia digitata	2.0
Sterculia sétigéra	0.9
Sterculia tomentosa	1.8
Guiera sénégalensis	0.9
Combretum aculeatum	1.8
(Total : 22 species)	(Total : 108 Observations)

TABLE 22

+ : Withered

0 : Present (not withered)

WITHERED SPECIES (PASTURE TRANSECTS)

N°.	Acacia sénégal	Commiphora africana	Acacia flava	Acacia raddiana	Grewia bicolor	Combretum aculeatum	Balanites aegyptiaca	Euphorbia balsamifera
1	0							
4	+			0			0	
5	+			0			+	
6	+						0	
9		+		0			0	
10			0	0			0	
11	0	+					0	+
12	0	+		0			0	0
13	0	+	0	0			0	0
14	+		0	0			0	
15			+	+			0	
17	0						0	
18	0						0	
19								
20	0	0	0		+			
22							0	
23	0		0	0			0	
24	0					+	0	
25		0	+			0	0	

TABLE 23

LIST OF REGENERATING WOODY SPECIES OBSERVED (SITE: LESS THAN 0.50 M TO 1 M): LOCATION AND FREQUENCY (SEE "PASTURE" TRANSECT SHEETS, IN ANNEX).

Woody Species	Pasture Numbers	Frequency (% of 73 Observations of regererating species)
Acacia Sénégal	4-5-6-11-13-14-17-18-20-23-24	15.0
Acacia raddiana	4-5-10-13-14-15-23	9.5
Acacia seyal	17-18-20-23-25	6.8
Acacia flava	10-13-14-20-23-25	8.2
Balanites aegyptiaca	4-5-6-10-11-12-13-14-15-16-17-18-23-24-25	20.5
Bauhinia rufescens	4	1.3
Maerua crassifolia	5-10-11-12-14-25	8.2
Calothropis procera	13-23	2.6
Euphorbia balsamifera	11-12-13	4.1
Capparis decidua	10-11-15	4.1
Boscia sénégalensis	11-25	2.6
Commiphora africana	12-13-25	4.1
Combretum glutinosum	17-20-22-24	5.4
Zizyphus mauritania	20-25	2.6
Guiera sénégalensis	22	1.3
Combretum aculeatum	24-25	2.6
(Total: 16 species)		(Total: 73 Observations)

TABLE 24

GRASS COVER

+ Presence

o absence

Pasture Number	Grass Cover	Coverage Rate (%)
1	+	≤ 5
4	+	≤ 5
5	+	≤ 5
6	+	≤ 5
9	o	
10	o	
11	+	± 20
12	+	≤ 5
13	+	≤ 5
14	+	≤ 5
15	o	
17	+	± 10
18	+	± 10
19	+	≤ 5
20	o	
22	+	20 to 30
23	+	≤ 5
24	o	
25	+	≤ 5

TABLE 25

Pasture Number	Cutting	Zeriba	Cultivated Fields		Straw	Living Grass	Withering of Woody Species	Regeneration of Woody Species
			Former	Current				
1	+	+	+		+	+	+	
4	+				+		+	+
5	+	+	+		+		+	+
6	+					+	+	+
9	+						+	
10	+							++
11					+	+	+	+
12						+	+	+
13					+	+	+	+
14						+	+	+
15	+	+		+			+	+
17	+			+		+		+
18	+	+			+			+
19	+	+		+	+			
20							+	+
22					+	+		+
23	+				+			+
24	+						+	+
25	+					+	+	%

3-7) STATE OF CLASSIFIED FORESTS (See Figures 20 through 23, Annex 1)

General Situation

Most of Mauritania's classified forests are in deplorable condition. This cannot be attributed to climate alone; part of the degradation stems from the actions of man, often uniformed or uninterested in the preservation of the forest heritage of the country, especially because of speculation in charcoal.

In order to study this alarming situation, we visited and performed vegetation transects in 16 classified forests and 1 rewooded perim Most observations were made along the Senegal River, where are found the Gonakié (Acacia nilotica) classified forests. These trees are of undeniable economic importance, as they furnish almost all the wood charcoal produced in Mauritania for distribution throughout the nation.

1) Mauritanian Classified Forests

Mauritania has 37 classified forests, one sylvo-pastoral reserve, and 2 rewooded perimeters, distributed as follows (by Administrative Region).[28]

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(28) Based on list of classified forests by Administrative Region supplied by the Direction de la Protection de la Nature (see Table 26). This list has not been updated since it was established.

TRARZA (Region 6)	:	14 classified forests (84 897 hectares) 2 rewooded perimeters (121 ha, 21 ares)
BRAKNA (Region 5)	:	11 classified forests (12 920 ha) 1 sylvo-pastoral reserve (1 992 ha)
GORGOL (Region 4)	:	5 classified forests (4 452.9 ha)
ASSABA (Region 3)	:	2 classified forests (16 105 ha)
HODH EL GHARBI (Region 2)	:	1 classified forest (1 650 ha)
TAGANT	:	3 classified forests (5 995 ha)
GUIDIMAKA	:	1 classified forest (706 ha)

Table 26 shows more detailed information on each classified forest, by administrative region, at the date of classification: location, surface area, and tree population.

The total surface area of classified forests was 126,725.9 hectares before Independance.

It is important to note that the surface areas measured at the time of classification of these forests do not generally correspond to present reality for several reasons: the population has moved the boundary markers in order to clear land for crops (in the Senegal River oualo lands), and has exploited the wood. The drought has combined with human pressures to cause thousands of hectares of forest to disappear.

There are two categories of classified forest:

a) Gonakié (Acacia nilotica) forests, along the Senegal River in the

Oualo, which in 1972 covered a surface area of 20,204 ha.[29/]

b) Other classified forests, which represent, excluding the Senegal River valley forests, a surface area of 106,521.9 hectares (or 126,725.9 ha less 20,204 hectares of Gonakié forest.) These forests are located outside the Senegal River valley and are mainly composed of gum trees (Acacia senegal).

2. Unclassified Forests

In 1972, unclassified forests represented about 6,000 hectares along the Senegal River.[30/]

3.7.1 Disappearance of Classified Forests

Between 1972 and 1977, 43% of classified Gonakié forests along the Senegal River disappeared (about 8,687 hectares) due to over-exploitation of wood charcoal, clearing for crops and drought. The remaining forests have a surface area of about 11,516 hectares.[31/] In addition, the OMVS estimates that 1,065 hectares of Gonakié will be flooded by construction of the Diama Dam, and 7.570 additional hectares affected by changes in the river's flood cycle.[32/]

29/and 30/ R. Perraudin, 1972, "Rapports sur les missions effectuées en Mauritanie, Sénégal, au Sudan" AFR/REG/62.

31/ R. Winterbottom, "Compte Rendu de la mission effectuée du 20 au 28 juillet, 1979 à Nouakchott", CILSS/DPP. Equipe Ecologie/Coût.

32/ R. Winterbottom, "Compte Rendu de la mission effectuée du 19 mars au 14 avril, 1980 à Nouakchott", CILSS/DPP.

The NAS (U.S. National Academy of Sciences)[33/] estimates that 20,000 to 25,000 hectares of Gonakié will be damaged by the construction of the OMVS dams. It must be remembered that the construction of the Diama and Manantali dams will have both a positive and a negative impact on the environment in the Senegal River basin; these impacts have been studied by the OMVS ("Evaluation des effets sur l'environnement d'aménagements prévus dans le basin du Fleuve Senegal," 1977).

At present, only 40% of the wooded surface areas of all the classified forests of Mauritania remain due to drought, cutting for firewood and cutting for livestock fodder. [34/]

Given the current rate of over-exploitation for production of wood charcoal and the continiung rainfall deficit, the classified forests along the Senegal River (and particularly between Rosso and Boghé) will totally disappear in the next 6 to 8 years, or perhaps even sooner. [35/]

A recent field survey by the RAMS Geographical Research/Environment Unit [36/], observed the degradation of the classified forests along the Senegal River, which has not been caused by climatic conditions alone. The complete disappearance of the Gonakier forests, given the present rate of cutting, is imminent. The conclusions of this report agree with the pessimistic estimates mentioned above, that is, that the complete annihilation of these forests is to happen soon -- between 1986 and 1988 -- if nothing is done to stop the ravage and to reconstitute the forests.

33/ NAS Mission, April and September 1979, Mauritania.

34/ R. Winterbottom, "Compte Rendu de la mission effectuée du 20 au 28 juillet, 1979 à Nouakchott", CILSS/DPP - Equipe Ecologie Forêts.

35/ John Heermans, 1980, Forestry Expert, Consultation for USAID.

36/ RAMS Mission, 5/29/80 to 6/4/80.

3.7.2 ANALYSIS OF FIELD OBSERVATIONS (See Location Maps in the Annex).

17 of the 36 classified forests of Mauritania were surveyed (see Table 26), as well as one rewooded perimeter. The distribution of these classified forests is as follows:

10 Gonakié classified forests in Senegal River oualo lands

1 Gonakié classified forest in the interior of the country, in the Tamourt along : . Tamchakett.

3 Gum tree groves (Acacia senegal) in the Trarza

1 Gum tree grove in the Assaba

1 mixed classified forest (without Gonakié) in the fondé near Rosso.

1 rewooded perimeter in the fondé near Rosso (which has now become barren land)

Most Gonakié classified forests studied were between Rosso and Boghé.

a. Classified Forests Studied Along the Senegal River (See Transect Sheets in Annex).

1. GANI FOREST (No 7 on Map)

This is an old Gonakié forest. The remaining trees are from 5 to 6 meters high, with trunks of more than 20 cm in diameter. This forest is in deplorable condition, for the following reasons:

- since 1967-68 the annual floods have not reached the Gonakiés on higher ground; thus, they are extremely withered. In the low-lands the remaining trees have been less damaged by drought, but have been

subject to over-exploitation. Even green trees are cut, as the local population considers green wood yields better quality charcoal and requires smaller quantities than dead wood. Living Gonakié branches are also cut to feed livestock and to harvest the pods, used in tanning leather.

The numerous trees stumps and charcoal ovens observed in this classified forest attest to the intense over-exploitation of the Gonakié. No reganeration of Gonakié trees was observed.

2. DAGANA FOREST (Keur Mour) (No 6 on Map)

This is also an old Gonakié forest, populated by trees more than 10 meters high.

Along the banks of the Senegal River are found large Borassus flabellifer. The Gonakiés of this forest have been intensely exploited (even at its center, far from the track) for wood charcoal. In addition, to trees which have died from drought, green trees have been felled. The RAMS survey team observed numerous charcoal manufacturers at work in the heart of this forest, without government interference.

There are many clearings in this forest, invaded by Salvadora persica and Tamarix senegalensis. In this forest, cutting is largely responsible for degradation; only a small number of withered trees were observed.

No Gonakié regeneration (young plants) was observed in the Dagana forest. Only a few tree stumps along the river presented young shoots.

3. TESSEM FOREST (No 8 on Map)

This forest is populated exclusively by Acacia nilotica of from 6 to 7 meters high. It has been degraded by the drought and by intense cutting for fabrication of roofing beams and firewood, livestock feed and harvesting of pods.

Many animals (camels and goats) were observed ranging in this forest. However, this forest does not appear to be exploited for wood charcoal; no charcoal ovens were found, in spite of an intensive search. There is no natural regeneration of Gonakiés in the Tessem forest.

4. M'BOY O FOREST (No 9 on Map)

Gonakié stands are very withered; about 80% of the trees are dead. Only a few large Acacia nilotica have survived in the lower oualo areas. However, it should be noted that a certain amount of natural regeneration is evidenced by groups of young Gonakiés (0.50 to 2.3 meters high) in certain small depressions flooded by rainwater (but not by the annual river floods).

Certain zones of this classified forest are populated at present by Balanites aegyptiaca, Salvadora persica and Acacia seyal, which have progressively replaced the dead Gonakiés.

On the edge of this forest numerous Gonakié stumps attest to intensive exploitation for wood charcoal. The charcoal is fabricated outside the forest itself, in so-called "protected domains", where several charcoal ovens were observed.

5. DAR EL BARKA FOREST (No 10 on Map)

This forest is dominated (80%) by old Gonakié trees of from 15 to 20 meters high. More than 50% of these trees have died of withering. Those still living in the lower oualo lands are in poor condition; they have been mutilated by branch cutting to provide fodder for large numbers of ranging animals. No charcoal ovens exist in the forest itself; they are found in the surrounding Gonakié "protected domains".

In the Dar El Barka forest, other species are progressively replacing the disappearing Acacia nilotica: Balanites aegyptiaca, Cadaba farinosa, and Salix senegalensis.

No signs of natural regeneration of the Gonakié tree were found in the Dar El Barka forest.

6. OLO-OLOGO FOREST (No 11 on Map)

Only a few Acacia nilotica trees remain in this old Gonakié forest. Balanites aegyptiaca has become the dominant species (about 60%). Capparis decidua and Boscia senegalensis also grow in areas where Acacia nilotica has disappeared.

This forest has suffered from intense cutting, as evidenced by numerous relatively old tree stumps. At present, Balanites aegyptiaca and Capparis decidua suffer intense branch cutting for livestock fodder. Numerous sheep and goats were observed ranging in the Olo-Ologo forest.

The forest is composed of relativel young plants, of heights varying from 50 cm to 3 meters for all species. Young Acacia nilotica although rather scarce, attest to modest regeneration of this plant under current climate conditions.

No charcoal ovens were found in the forest or its surroundings.

7. SILBE FOREST (No 12 on Map)

This old forest is dominated by almost 50% Acacia nilotica, which have an average height of more than 10 meters. More than 50% of these Gonakiés are withered, either standing or fallen. The weakened or dead trees are gnawed by termites and collapse.

This forest is intensely exploited for wood charcoal. The remaining green trees are not spared; in order to avoid laborious wood cutting, the tree's base is set afire to make it fall. Numerous large charcoal ovens are located in the heart of this classified forest.

Secondary species are progressively replacing the Gonakié: Balanites aegyptiaca, Boscia senegalensis, Bauhinia reticulata, Capparis decidua, Bauhinia rufenscens.

No regeneration of Gonakié trees was observed, even in the lower lands.

8. LOPEL FOREST (No 13 on Map)

This is an old Gonakié forest, dominated by more than 80% Acacia nilotica, which attain more than 10 meters.

It is located in a narrow strip along the Senegal River. Its outer limits to the north are formed by the dikes being built on the Boghé plain; a large part of this forest was cleared for these irrigation works.

The remaining Acacia nilotica population is relatively well preserved and does not seem to have suffered from the drought (very little withering was observed). This is probably due to the low-lying site and the proximity of the Senegal River, which provides an alluvial aquifer into which the trees sink their roots.

However, on higher lands, a few withered trees or less dense Gonakié populations are found.

In the clearings, other species are encountered: Zizyphus mauritiana, Acacia albida, Bauhinia rufescens and Indigofera sp.

No charcoal ovens were observed in this forest. However, the forest is endangered on a more or less long term basis by cutting for animal feed (numerous camels and goats) and for wood to provide fencing and roofing (we observed one man with an axe, who fled at our arrival).

No sign of Gonakié regeneration was found.

9. GANKI FOREST (No 14 on Map)

This forest is still dominated by Acacia nilotica (more than 60% of species encountered). It is not very dense, and numerous signs of

of old and new mutilations were observed: cutting for firewood and livestock feed, clearing, numerous ranging goats, sheep and camels. In fact, this forest ressembles the neighboring unclassified sectors, having very degraded vegetation due to clearing for crops. Only the old markers (most of which have been displaced) indicate the original forest boundaries. Other species are replacing the Gonakié: Acacia seyal and Indigofera sp. (about 40% of trees observed).

There are no charcoal ovens in the Ganki classified forest. No signs of natural regeneration of the Acacia nilotica were observed.

10. OUALALDE FOREST (No 15 on Map)

This classified forest is populated by about 80% Acacia nilotica, most of which are large. However, these Gonakiés have been greatly affected by the drought; many have withered and died.

The live trees are subjected to intensive cutting for livestock feed, gathering of pods and fabrication of roofing beams.

Dead trees are used for firewood. The other species (about 20%) are: Balanites aegyptiaca, Bauhinia rufescens, Acacia seyal, Capparis decidua, Salix senegalensis.

Acacia nilotica is not regenerating and is being progressively replaced, especially in the high lands, by secondary species.

No charcoal ovens were observed in the Oualaldé Forest or its surroundings.

. MAGHAMA (N' GOUYE) FOREST (No 16 on Map)

This classified forest was originally entirely populated by Acacia nilotica. At present, this tree represents only 40% of species observed, other trees have progressively replaced the disappearing Gonakié: Bauhinia reticulata has become dominant on the edges of the forest and in its numerous clearings. Bauhinia rufescens and Balanites aegyptiaca are also found. There are few signs of cutting, except at the edges of the forest, where a few trees have been burned at the base.

On the other hand, almost everywhere, the Gonakiés were observed to be quite withered. Many are still standing, although dead; others have fallen into piles of dried branches.

Termites attack almost all of the dead trees and even the trunks of weakened living trees.

All the species encountered had young plants. Impressive regeneration of Gonakiés was observed along the Paliba marigot to the north of the forest. Plants about 50 cm high were seen over large areas to be developing so densely as to ressemble bushes.

). CLASSIFIED GONAKIE FORESTS OUTSIDE THE SENEGAL RIVER VALLEY

). TAMCHAKETT FOREST (No 18 on Map)

This classified forest spreads below the town of Tamchakett in the Tamourt Valley, fed by the Takhtaya Oued, whose waters come from the El Haguer Mountain in the sandstone Affolé Massive.

It is a superb Acacia nilotica forest -- dense, with many old trees, often more than 10 meters high. It covers the central part of the Tamchakett Tamourt over about 20 km. During the rainy season, the waters rise to cover several meters of the Gonakié trunks.

This forest has not been affected by the drought, due to sufficient water supplies from the Affolé. However, a total lack of regeneration was observed; no young plants are to be found. It is to be feared that eventually the old Gonakiés will disappear without being replaced. Young shoots cannot develop in this forest due to intense ranging in the underwood by numerous goats, sheep and camels.

Note: There is a very marked contrast between the green and prosperous Tamourt and the surrounding arid dunes. The dunes bordering the Tamchakett Tamourt present various species suffering from drought and cutting for firewood and livestock fodder. Most of the gum trees have disappeared. Commiphora africana has also sustained heavy losses. The dominant Acacia raddiana appears to be more resistant to human and climatic pressures.

c. Other Classified Forest Studied

Classified forests populated by Acacia senegal are generally located in sand dune milieus; some of these dunes, as in the Trarza, are in the process of remobilization.

13. BOUTILIS FOREST (No 13 on Map)

This classified forest is located 10 km east of the village of Tiguent (Village No 8), in the Trarza dunes.

Dominated by about 50% gum trees (Acacia senegal), this forest is in deplorable condition. More than 80% of the gum trees are dead or withering, forming veritable cemetaries of fallen trees and debris. The same proportion of dead trees was found for secondary species (Acacia raddiana and Balanites aegyptiaca).

However, Maerua crassifolia, located in depressions (gouds) has been little affected by the drought. Nevertheless, it has been overgrazed by livestock and extremely mutilated by cutting.

At its creation in 1946, the Boutilis forest was originally a mixed forest, dominated by Acacia senegal and Acacia raddiana. Leptadenia spartium, Capparis decidua, Balanites aegyptiaca and Maerua crassifolia were also found.

At present, it is a "classified forest" in name only, as nothing distinguishes it from the surrounding environment.

There is some modest regeneration; all species observed were a few young plants. However, the fairly numerous goats and camels in this forest may prevent the continuation of the natural regeneration process.

14. TINE-YERA FOREST (No 4 on Map)

The Tine-yera classified forest is located several kilometers north of Mederdra (see aerial photograph study in Chapter 3-4-4). It was classified on 11/21/45 as a gum tree grove.

At present, very little remains of this Acacia senegal forest; about 50% of the gum trees are dead. Balanites aegyptiaca has become dominant, followed by Acacia raddiana.

Calothropis procera is present, attesting to the degradation of the soil.

Maerua crassifolia and Zizyphus mauritiana (rare) are found in the gouds.

This forest has considerably thinned since 1954 (IGN aerial photographs). At present, it can hardly be distinguished from its environmentally degraded surroundings.

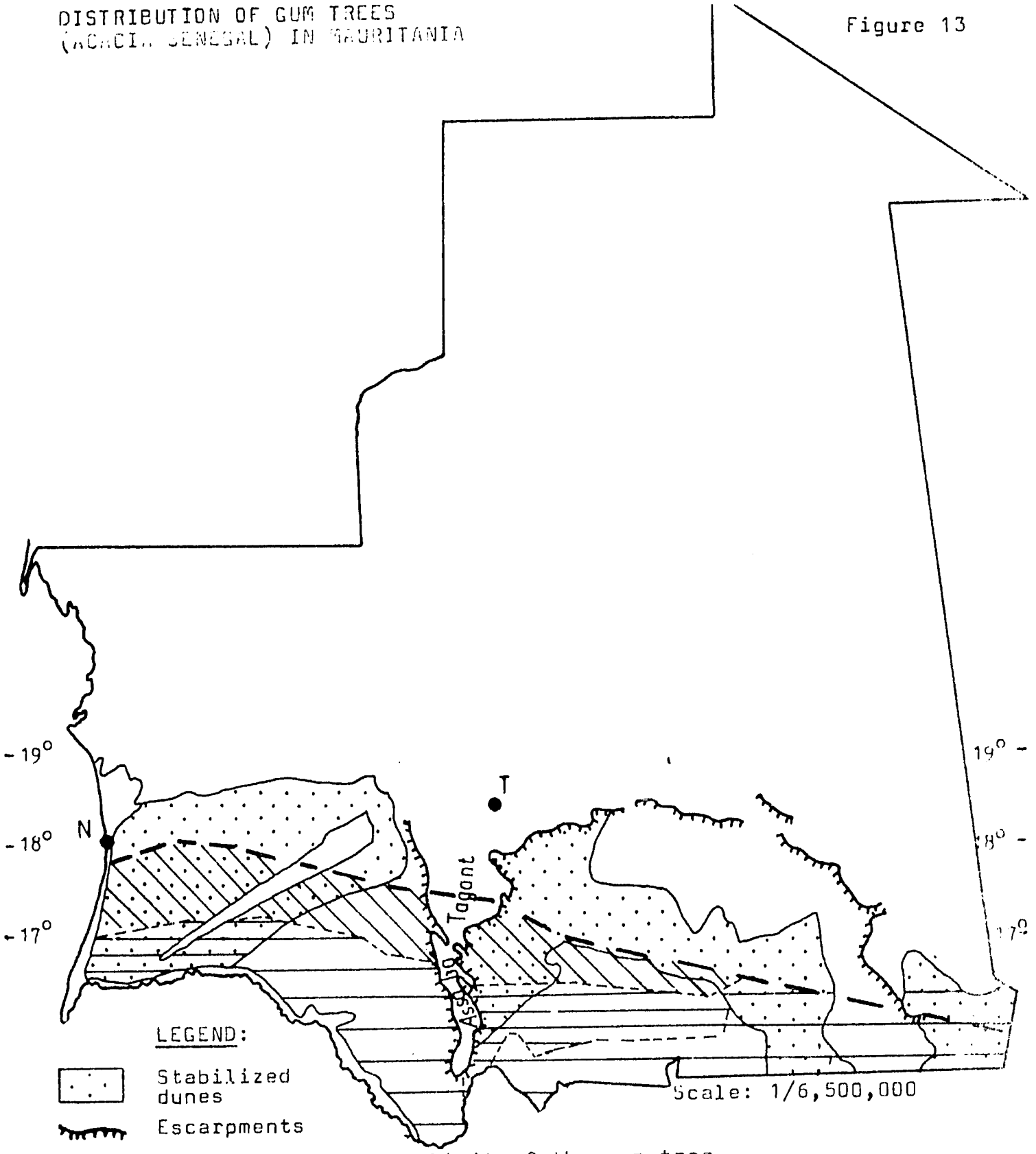
Nevertheless, very modest natural regeneration can be seen for most species. However, animal ranging may compromise regeneration if no protective measures are taken.

15. KRAA EL AHMAR FOREST (No 5 on Map)

This classified forest is located on the Trarza dune massive several kilometers to the south of Mederdra. Originally, it was a pure gum grove, planted by the colonial administration and classified in 1938. At present, the forest is invaded by secondary species: Balanites aegyptiaca and Acacia senegal.

DISTRIBUTION OF GUM TREES
(ACACIA SENEGAL) IN MAURITANIA

Figure 13



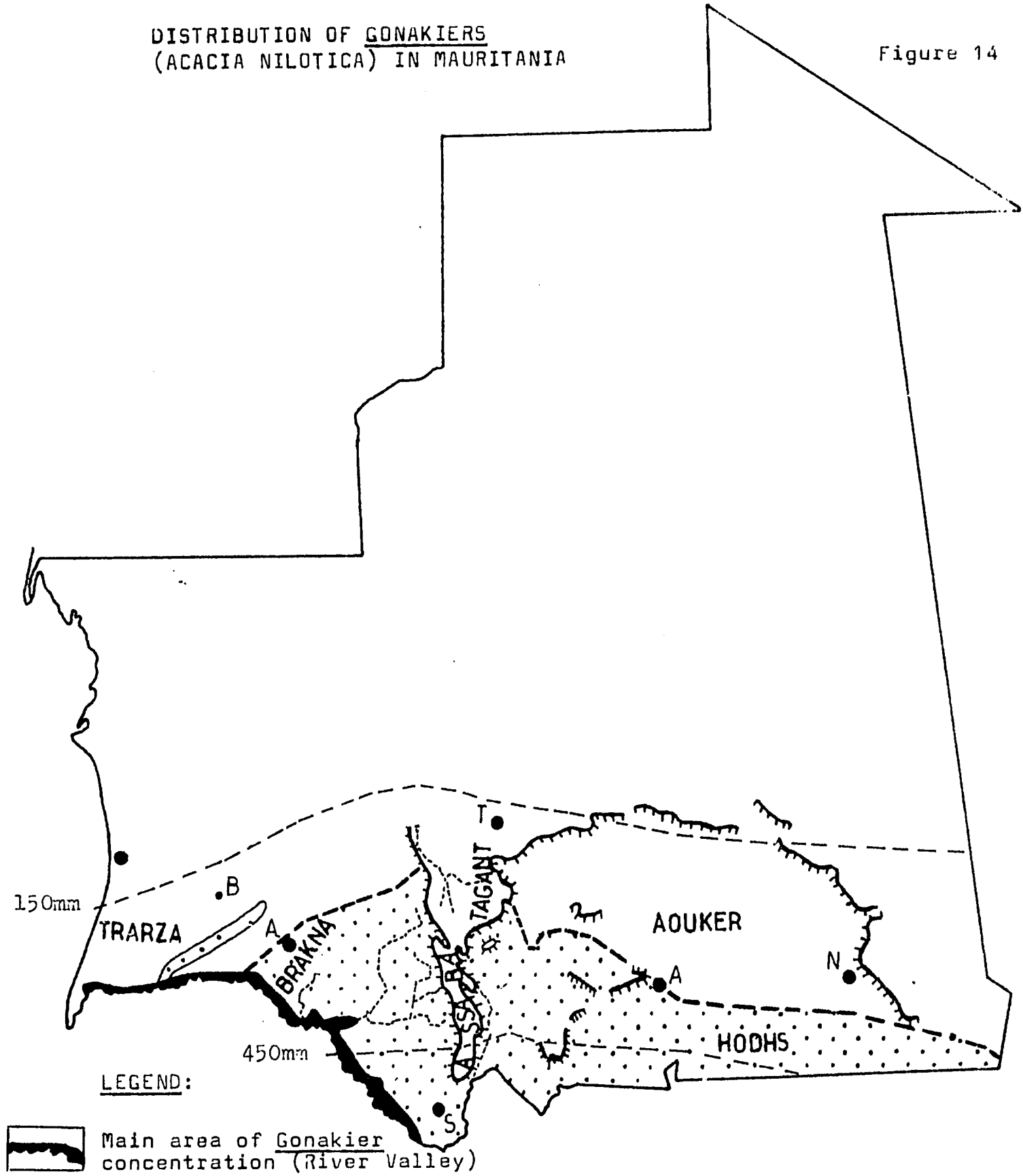
LEGEND:

- Stabilized dunes
- Escarpments
- Approximate northern limit of the gum tree
- Area of serious deterioration of gum trees growing on stabilized dunes
- Area of deterioration of the gum tree in the Aftout and other milieux
- Main habitat of gum trees today
- Areas of sparse gum tree growth

Source:
Author, RAMS, 1980.

DISTRIBUTION OF GONAKIERS
(ACACIA NILOTICA) IN MAURITANIA

Figure 14



LEGEND:

Main area of Gonakier concentration (River Valley)

Concentration along main wadis

Areas of spare growth, esp. in wadis, bottom land.

Approximate northern limit of Gonakier growth

Source: Author (RAMS, 1980)

While Acacia senegal still dominates (about 50% of species observed), about 40% of these gum trees are dead or withering, most having fallen. We also noted intensive cutting for livestock fodder.

In this forest we observed a relatively large amount of natural regeneration of the three above-cited woody species, although it is perturbed by animal ranging.

This classified forest is in better condition than the Tine-yera forest located to the north of Mederdra.

16. NEHAME FOREST (No 18 on Map)

This old gum tree grove was classified in 1950. It is located to the south of Kiffa in fixed dune belts.

Acacia senegal is still dominant (about 80%), but other species have invaded due to thinning of the gum tree forest: Balanites aegyptiaca, Conbretum glutinosum, Capparis decidua, Calothropis procera. Hyphaena thebaica can be found in the low lands.

Certain zones of this forest are well preserved and still densely populated with gum trees.

In most of the forest, good natural regeneration is observed; there are a large number of young gum plants of from 50 cm to 1 meter high.

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d. Other Types of Classified Forests

17. TINE-BUNAR FOREST (No 1 on Map)

This classified forest is located about 9 km northwest of Rosso, in fondé lands. Originally, in 1941, it was a mixed forest, populated by *Acacia senegal*, *Balanites aegyptiaca*, *Acacia nilotica* and *Tamarix aphylla*.

In 1958, a "ronier" plantation was installed on about 4 hectares, but these trees did not develop well, mainly due to livestock (goats, sheep, cattle) ranging and eating the young shoots as soon as they appeared.

At present, this "classified forest" is quite degraded and dominated by 80% *Gymnesperia senegalensis*. Other species found are: *Acacia seyal*, *Balanites aegyptiaca*, *Acacia senegal*(+), *Acacia albida*(+), *Zizyphus mauritania* (+), *Bauhinia rufescens*(+), *Indigofera sp.*(+), *Borassus flabellifer*, *Salvadora persica*, and on the edges *Tamarix aphylla*. (The species marked by a "+" have appeared since the date of classification).

Acacia nilotica and *Bauhinia reticulata* have disappeared from this classified forest, most certainly because their wood has been over-exploited by inhabitants of the town of Rosso.

With the exception of *Acacia albida*, *Acacia senegal*, *Salvadora persica*, *Bauhinia rufescens*, young plants were observed for all other species. However, cutting and animal ranging are found everywhere in

this forest, which is rapidly disappearing. Numerous dried stumps testify to particularly intense exploitation in the past (clearing for cultivation and exploitation of Gonakiés).

18. TOUGUEN REWOODED PERIMETER

This rewooded perimeter is located on the edge of the town of Rosso on fondé lands, adjacent to the Lycée. It ressembles a "vacant lot". Established in 1948, it was planted with gum trees and "roniers". Today, no sign of these plants exist. A few old Gonakié stumps testify to the former presence of an Acacia nilotica forest.

The boundary markers and rusted remains of metal stakes for fencing can still be seen around the perimeter. It is, at present, very sparsely populated by Tamarix aphylla (dominant), a few Balanites aegyptiaca, Prosopis sp. (disseminated from the trees in the Lycée courtyard), Acacia seyal and Acacia albida.

Tamarix senegalensis seems to be progressively invading the perimeter, as it is much less sought after by woodcutters and livestock (there are very few camels at Rosso) than the other species.

3.7.3 SUMMARY OF CONDITION

1) Woody Species

For all the 18 classified forests visited (including 1 rewooded perimeter), 22 woody species were observed, given in the following list:

Gymnesporia	senegalensis
Acacia	seyal
Borassus	flabellifer
Balanites	aegyptiaca
Acacia	senegal
Acacia	albida
Zizyphus	mauritiana
Salvador a	persica
Indigofera	sp.
Bauhinia	rufescens
Tamarix	aphylla
Prosopis	sp.
Acacia	raddiana
Maerua	crassifolia
Calothropis	procera
Acacia	nilotica
Cadaba	farinosa
Salix	senegalensis
Capparis	decidua
Boscia	senegalensis
Bauhinia	reticulata
Combretum	glutinosum

Balanites aegyptiaca is omnipresent. It was observed in almost all the transects. Its frequency was 16% of the 75 observations in 18 classified forests.

Table 27 gives the list of the 15 species found in the classified forests surveyed in the Senegal River oualo lands. Acacia nilotica is, of course, dominant. It is interesting to note the relatively great

frequency of Balanites aegyptiaca (14%) which have been replanted in the classified forests, followed by Bauhinia rufescens (frequency: 9.52%), Capparis decidua and Acacia seyal (frequency: 7.14%).

Thus, table 27 clearly shows the intrusion of other woody species in place of the disappearing Gonakiés, which have been cut for wood charcoal and withered by drought.

Table 28 lists the 16 species found in the 5 other classified forests and the rewooded perimeter. By comparing Tables 27 and 28, one notes that 8 species are found both in the Senegal River oualo classified forests and the classified forests located on diéri lands outside the river valley. These 8 species are: Balanites aegyptiaca, Bauhinia rufescens, Capparis decidua, Acacia seyal, Salvadora persica, Indigofera sp., Zizyphus mauritiana.

Table 28 shows that Balanites aegyptiaca was the most frequently observed in diéri forests (18.18%), followed by Acacia senegal (frequency: 15.15%). This table demonstrates that the Balanites aegyptiaca and other species have begun to replace the gum trees, which have been greatly affected by the drought due to weakening by massive bleeding for gum arabic.

Table 29 lists all the species found to be withered for each classified forest. In all the oualo forests, Acacia nilotica was observed to be withered. However, they were not affected by the drought in the Tamourt Tamchakett, far from the Senegal River.

Table 30 presents the degree of withering observed for Acacia nilotica in the 11 oualo forests.

REGENERATION OF WOODY SPECIES

Table 31 shows which woody species possess young plants (50 cm to 1 m high), indicating natural regeneration. This table covers all the classified forests studied and summarizes the information given in the text and the transect sheets in the Annex.

Again, the predominance of Balanites aegyptiaca was observed (frequency: 22.44%). It is interesting to note that the gum tree was also frequently observed to be in the process of natural regeneration (8.16%).

This table clearly demonstrates that natural regeneration is possible for a great number of species, and can be favorized by appropriate protection measures. Ranging animals are a constant hindrance to the survival and growth of regenerating species, as they graze on or trample the young plants. Acacia nilotica is not regenerating well due to animal ranging and the absence of regular floods since the drought began.

2) The Herbaceous Cover

Table 32 shows, for each classified forest, the rate of grass coverage expressed as a percent. It shows that in most cases, herbaceous cover is absent. In only 7 classified forests were straws observed on the soil, most of which were Cenchrus biflerus (see Transect Sheets in Annex). The observation were performed at the end of the dry season, which was not a favorable period for the study of herbaceous cover.

3) Mention must be made of termite action. In all the Gonakié forests in the Senegal River oualo, termites proliferate in areas where large numbers of trees are withered. They attack weakened trees and may precipitate the death of Gonakiés.

On the other hand, they literally "clean" the underwood, progressively eliminating the piles of dead branches on the ground. If normal floods reappear in the future, this may favorize natural regeneration.

TABLE 26 - CLASSIFIED FOREST: SITUATION AS OF CLASSIFICATION DATES
(SOURCE: DIRECTION OF NATURE PROTECTION - IRM)

REGION : TRARZA (06)

NAMES	CLASSIFICATION DECREE	SURFACE AREA	TYPE	TREE POPULATION
Gani	No 730/SE of 2/22/43	7050 ha	Classified forest	- Gonakiers - Souroum - gum trees
Berbeira	No 772/SL/F of 2/27/46	3000 ha	Classified forest	- gum tree (acacia senegal) - Acacia tortilis - Balanites aegyptiaca - Maerua crassifolia (secondary) - Capparis (secondary)
Bouajra	No 2090/SE of 6/24/38	320 ha	" "	- Roniers
Niar Keim	No 4366/SE/F of 9/22/48	10 000 ha	" "	-Acacia senegal
Tine-Bunar	No 2150/SE and 2152 of 6/17/41	730 ha	" "	- Acacia senegal - Balanites aegyptiaca - Tamarix
Dioïa	No 2151/SE/ of 6/17/41	627 ha	" "	- Gonakié (dominant) - Bauhinia réticulata - Acacia seyal - Salvadora persica
Mederdra	No 2089/SE of 6/24/38	5 540 ha	" "	- Gum trees
Mederdra	No 145_/SE/F	54 ha 2 ares	Rewooded perimeter	- Gum trees, Acacia raddiana - Balanites aegyptiaca (situation as of 5/23/80)
Toungein	No 1277/FOR	67 ha	Rewooded perimeter	- Situation as of 5/30/80 Practically nothing remains except a few Balanites aegyptiaca and prosopis sp. (near Rosso Lycée)

TABLE 26 (Cont.)

Agdarnit	No 4364/SE/F of 9/22/48	4 400 ha	Classified forest	Acacia senegal
Douch	No 4367/SE/F of 9/22/48	34 000 ha	Classified forest	Acacia senegal
Boudeifia	No 4365/SE/F of 9/22/48	3 100 ha	" "	Acacia senegal
Boutilis	No 773/SE/F of 2/27/45	20 000 ha	" "	Acacia senegal (dominant) Tortilis (dominant) Balanites aegyptiaca Leptadenia spartium Capparis Maerua crassifolia
Tin-Yera	No 3519/SE/F of 11/21/45	1 100 ha	" "	Acacia senegal
Baouadji	No 3182/SE/F of 9/10/41	486 ha	" "	species ?
Keur-four (Dagana)	?	540 ha	" "	Gonakiers
REGION . BRAKNA (05)				
Louboudou Dar-el Barka	No 2393/58	328 ha	Classified forest	Gonakiers
Silbé	Decree No 10 028	2 736 ha	" "	Gonakiers
Toueiddéri	No 5 846/SE/F	62 ha	" "	Gonakiers
Lopel	No 1626/SE of 4/21/46	582 ha	" "	Gonakiers
Tessem	No 1622/SE/F	453 ha	" "	Gonakiers
Afuya	No 8112/SE/F of 11/4/53	507 ha	" "	Gommiers
Ganki	No 1624/SE of 4/30/47	600 ha	" "	Gonakiers
M'Boyo	No 1624/SE of 4/21/46	2 690 ha	" "	Gonakiers
Koundi	No 3183/SE of 9/10/41	4 470 ha	" "	Gonakiers
Olo-Ologo	No 1623/SE of 4/2/46	217 ha	" "	Gonakiers
Walaidé	No 1625/SE of 4/30/47	275 ha	" "	Gonakiers
Ferruga	No 1471/SE/F	1 922 ha	Sylvo-pastoral reserve	species ?

TABLE 26 (Cont.)

NAMES	CLASSIFICATION DECREE	SURFACE AREA	TYPE	TREE POPULATION
REGION : GORGOL (04)				
Yama N'Diaye	No 5 850/SE/F of 10/25/50	530 ha	Classified forest	- Gonakiers
Dindi	No 2 497/SE/ of 4/4/55	395 ha	" "	- Gonakiers
N'Goye	No 3 747/SE/F of 6/14/52	1 825 ha	" "	- Gonakiers
Dao	No 1 841/SE/F	957.9 ha	" "	- Gonakiers
Diorbivol	No 5 949	745 ha	" "	- Gonakiers (dominant) - Acacia seyal - Faidherbia albida - Acacia Raddiana - Bauhinia Rufescens
Region : ASSABA (03)				
Nehamme	No 5 099/SE/F	13 040 ha	Classified Forest	- Hypaenia Thebaïca - Combretum locardu
Marai Seder	No 6 499/SE/F of 11/27/50	3 165 ha	" "	- Gommiers
REGION : HODH EL GHARBI (02)				
Tamourt Tamchakett	No 2 328/SE/F	1 650 ha	" "	- Gonakiers (dominant) - Commiphora africana
REGION : TAGENT (09)				
El Mehra	No 10 252 of 12/18/60	450 ha	" "	- Gonakiers (dominant) Roniers
Tintane	"	4 995 ha	" "	- species ?
Leigdeim	" "	550 ha	" "	
GUIDIMAKA				
Melgue	No 10 030	706 ha	" "	- Roniers (Borassus flabellifer)

TABLE 27

LIST OF WOODY SPECIES CENSUSED IN 11 GONAKIE (ACACIA NILOTICA) CLASSIFIED FORESTS OF THE SENEGAL RIVER OUALO AND FREQUENCY.

WOODY SPECIES	NUMBER OF OBSERVATIONS	FREQUENCY (%)
Acacia nilotica	11	26.1
Balanites aegyptiac	6	14
Bauhinia rufescens	4	9.5
Capparis decidua	3	7.1
Acacia seyal	3	7.1
Bauhinia reticulata	2	4.7
Boscia senegalensis	2	4.7
Salix senegalensis	2	4.7
Salvadora persica	2	4.7
Indigofera sp.	2	4.7
Cadaba farinosa	1	2.3
Zizyphus mauritiana	1	2.3
Tamarix aphylla	1	2.3
Acacia albida	1	2.3
Borassus flabellifer	1	2.3

(Total : 15 species) (42 observations)

TABLE 28

LIST OF WOODY SPECIES CENSUSED IN OTHER CLASSIFIED FORESTS (OUTSIDE SENEGAL RIVER OUALO) AND FREQUENCY

WOODY SPECIES	NUMBER OF OBSERVATIONS	FREQUENCY (%)
Gymnesporia senegalensis	1	3
Acacia seyal	2	6
Borassus flabellifer	1	3
Balanites aegyptiaca	6	18.1
Acacia senegal	5	15.1
Acacia albida	2	6
Zizyphus mauritiana	2	6
Salvadora persica	1	3
Indigofera sp.	2	6
Bauhinia rufescens	1	3
Acacia raddiana	3	9.0
Calothropis procera	2	6
Maerua crassifolia	2	6
Combretum glutinosum	1	3
Capparis decidua	1	3
Tamarix aphylla	1	3
Total : 16 species	Total : 33 observations	

TABLE 29 - WITHERED SPECIES - CLASSIFIED FORESTS

+ Withered

0 present (not withered)

No	Acacia nilotica	Balanites aegyptiaca	Acacia senegal	Acacia raddiana	Capparis decidua	Acacia seyal	Salvadora persica
1		0	0				0
2		0				0	
3		+	+	+			
4		+	+	0			
5		0	+	0			
6	+						+
7	+						
8	+						
9	+	+				+	+
10	+	0					
11	+	0			+		
12	+				0		
13	+	0					
14	+					0	
15	+	0			+	0	
16	+	0					
17		+	+		0		
18	0						

TABLE 30 - WITHERED STATE OF ACACIA NILOTICA IN CLASSIFIED FORESTS ALONG THE SENEGAL RIVER

CLASSIFIED FORESTS	VERY WITHERED	WITHERED	SLIGHTLY WITHERED
Gani	+		
Tessem		+	
M'Boyo	+		
Dar El Barka	+		
Olo-Ologo			+
Silbe		+	
Lopel		+	
Ganki			+
Oualaldé	+		
N'Gouye		+	
Keur Mour (Dagana)			+

TABLE 31 : LIST OF REGENERATING WOODY SPECIES (HAVING PLANTS 0.50 TO 1 METER HIGH). LOCATION AND FREQUENCY. (SEE TRANSECT SHEETS FOR "CLASSIFIED FORESTS" IN ANNEX).

WOODY SPECIES	CLASSIFIED FOREST NUMBER	FREQUENCY (PER NUMBER OBSERVATIONS OF REGENERATING SPECIES)
Gymnesporia senegalensis	1	2.0
Acacia seyal	1-2-9-14-15	10.2
Balanites aegyptiaca	1-2-3-4-5-9-11-13-15 16-17	22.4
Zizyphus mauritiana	1-13	4.0
Indigofera sp.	1-13-14	6.1
Tamarix senegalensis	2-19	4.o
Acacia albida	2-13	4.0
Acacia senegal	3-4-5-17	8.1
Acacia raddiana	3-4-5	6.1
Maerua crassifolia	3-4	4.0
Calothropis procera	4-17	4.0
Acacia nilotica	11-16	4.0
Capparis decidua	11-12-15-17	8.1
Boscia senegalensis	11-12	4.0
Bauhinia rufescens	13-15-16	6.1
Bauhinia reticulata	16	2.0
(Total : 16 species)		(Total : 49 Observations)

TABLE 32

GRASS COVER IN CLASSIFIED FORESTS

+ : present

0 : absent

CLASSIFIED FOREST NUMBER	GRASS COVER	COVERAGE RATE (%)
1	+	< 5
2	+	< 5
3	+	< 5
4	+	< 5
5	+	< 5
6	+	± 5
7	0	
8	0	
9	0	
10	0	
11	0	
12	0	
13	0	
14	+	< 5
15	0	
16	0	
17	0	
18	0	

3 - 8 : STATE OF PALM GROVE ENVIRONMENTS (See figure 19, Annex I)

In order to obtain an idea of the state of the environment of the palm groves in the southern third of Mauritania, a survey mission was conducted jointly with the RAMS expert working on the Oasis Sub-Sector. 37/

A total of 17 palm groves were visited; their names and administrativa regions are given below (see Location Map in Annex).

PALM GROVES	ADMINISTRATIVE REGIONS
Moudjeria	TAGANT (09)
El Hosseinia	"
La Houetat	"
N'Beika	"
Niemelane	"
Tidjikja	"
Rachid	"
El Khedia	"
Boukdeid	ASSABA (03
Kiffa	"
Guerou	"
Kamour	"
El Feye	"
Kouroudjel	"
Sani	"
Kankossa	"
Barkewol	"

37/ , for more information, see report, "Oasis Sub-Sector Study", RAMS.

- 8 palm groves are in the Tagant Administrative Region
- 9 palm groves are in the Assaba Administrative Region

The palm groves are distributed in the physical regions as follows (Table 33):

TABLE 33
PALM GROVE DISTRIBUTION

PALM GROVES	PHYSICAL REGIONS	AVERAGE RAINFALL 1931-1960 (MM)
Moudjeria	Below sandstone Tagant Massive (to the west)	225.9 mm
M'Beika	Tamourt En Naaj Valley - Tagant Plateau	(150-200 mm)
El Hosseinia	Bouraga Oued Valley - Tagant Plateau	(150-200 mm)
Niemelane	Niemelane Oued Valley - Tagant Plateau	(150-200 mm)
Tidjikja	Tidjikja Oued Valley - Tagant Plateau	142.3 mm
Rachid	Tidjikja Valley, 40 km Northwest of Tidjikja - Tagant Plateau	(± 150 mm)
Lahouetat	Tidjikja Oued Valley, 200 km Northwest of Tidjikja - Tagant Plateau	(± 150 mm)
El Khedia	Kraa Naga Oued Valley - Tagant Plateau	(200-250 mm)
Guerou	Oued flowing into a plain Northeast of the Assaba sandstone Massive	(300-350 mm)
Kamour	Calangali Oued Valley, on Northeast Edge of Assaba sandstone Plateau	(300-350 mm)
Boumdeid	Khlig Oued Valley, Oued flows into a sandy plain east below the Tagant.	(± 250 mm)
Kiffa	Sandy plain between Assaba and Affolé-Valley of Kiffa Oued	350.7 mm
El Feye	Kouroudjel Oued Valley - Sandy plain	(400-350 mm)
Kouroudjel	" " " " "	(400-350 mm)
Sani	Sani Oued Valley - Sandy plain West of Karakoro	(± 457.0 mm)
Kankossa	Karakoro valley - Sandy plain	457.0 mm
Barkewol	Barkewol Oued Depression - Aftout Rag West of the Assaba Massive.	(± 350 mm)

3.8.1 Brief Description of Observations for Each Palm Grove Visited

1. MOUDJERIA

The town of Moudjeria is located between dune belts (moving sands) to the west and the buttresses of the sandstone Tagant Massive in the east. There are two small palm groves at Moudjeria:

- one located in the narrow rocky valley above the town, fed by two springs.
- the other located west of the town, in the plain below the massive on a substraum consisting of a mixture of slope colluvia (rocks and pebbles) and mobile sands.

This latter palm grove is menaced by sand encroachment from the shifting dunes and by the lowering of the aquifer level due to the prolonged drought.

The two palm groves are also menaced by Wooly Aphids and Taka (Acariose) 38/

2. N'BEIKA

This palm grove is located in the large alluvial valley of the Tamourt en Naaj, carved through the Tagant plateau. It is one of the many palm groves spread along the Tamourt.

38/ For more information on parasite infestations, see ,Oasis Sub-Sector Study, RAMS.

This palm grove suffers from neither sand encroachment nor lack of water. However, it is attacked, as are most other groves, by Wooly Aphids and Taka.

3. EL HOSSEINIA

This palm grove is located in a narrow, rocky valley in the Tagant Massive, giving onto the large alluvial valley of the Bouraga oued (which flows into Tamourt en Naaj in the north).

It is fed by a perennial spring upstream from the rocky gorge.

Most of the palm trees are old, and many have fallen because their rooting has been hindered by large rocky formations and the action of water erosion which has exposed their bases.

Water is plentiful and there is no problem of sand encroachment.

However, Taka and Wooly Aphids menace this palm grove.

4. NIEMELANE

The Niemelane palm grove is located in the heart of the Tagant Plateau, between Moudjeria in the south and Tidjikja in the north. It covers about 2 km, located in a small, shallow oued valley.

This palm grove suffers from neither sand encroachment nor lowering of the oued alluvial aquifer.

However, Wooly Aphid and Taka affect the palm trees.

5. TIDJIKJA

The Tidjikja palm grove is spread along the Tidjikja Oued, to the north of the sandstone Tagant Massive. It consists of a series of discontinuous palm groves along the large oued valley on both sides of the town; each grove has a separate name.

The major problem is sand encroachment, present everywhere. O can see palm trees several meters high of which only the fronds stick above the sand, such is the amplitude of sand invasion.

According to the local population, the alluvial aquifer has lowered somewhat since the drought began. There are about 50 motor-pu ps at Tidjikja. In addition to the above problems, the palm trees are affected by Taka and Wooly Aphids.

6. RACHID

As a Tidjikja, these are a series of palm groves spread along the Tidjikja Oued over several kilometers, in the flat-bottomed, sandy alluvial valley, flanked by two rocky escarpments to the north of the Tagant Plateau.

There is a permanent spring in the middle of the oldest palm grove visited. In several areas where the soil has been cut, one can observe salt concretions; according to the local population, these do not affect the palm trees.

The level of the oued alluvial aquifer fluctuates only slightly (six motor-pumps were found at Rachid).

Most palm groves are affected by Wooly aphids and Taka.

There is no sand encroachment problem around Rachid.

7. LAHOUETAT

This palm grove is located about 20 km to the southeast of Rachid, on the sandy edge of the Tidjikja oued. The topography is fairly flat, with no escarpments.

Sand encroachment is acute; the palm grove is almost totally submerged by sand. A good number of palm trees have already been completely buried; others can be seen to have only their top fronds sticking out of the sand. According to local date growers, most of these trees are from 5 to 6 meters high.

In addition, this palm grove has a salinization problem; the water has a tendency to be brackish.

Taka and Wooly Aphids are also a menace to this palm grove.

8. EL KHEDIA

The El Khedia palm grove is located in the Kraâ Naga oued valley, next to a rocky escarpment in the east, on the Tagant Plateau. It exists since 1925, when it was frequented only by nomads. Since 1958, a large village has grown up near this grove.

This palm grove suffers considerably from lowering of the alluvial aquifer, which has not been well replenished since the drought began. Many palm trees are withered and produce no dates.

There are only one or two motor-pumps at El Khedia.

Due to the considerable weakening of the palm trees from lack of water in the alluvial aquifer, the trees are particularly susceptible to attacks from Taka and Wooly Aphids, which are progressively exterminating them. The palm grove is not menaced by sand encroachment.

9. BOUMDEID (Boumdeid "l'ancien")

This is a very small palm grove, in poor condition, located on the edge of the Khlig Ouled oued, below an agricultural dam. This palm grove was planted by disciples of a Muslim agricultural religious community, the ABEL ADDE.

It suffers from a lowering of the alluvial aquifer (withering of some palm trees) and is menaced by sand encroachment from the neighboring dunes.

10. KIFFA

Located on the immediate edge of the town of Kiffa, this palm grove extends along the sandy banks of a oued. The palm trees have somewhat suffered from the lowering of the alluvial aquifer due to the prolonged drought. There are very few motor-pumps. The well water is becoming slightly salty.

Here again, Wooly Aphids and Taka affect many palm trees. However, sand encroachment is not a problem.

11. GUEROU

The Guérou palm grove is the largest of the Assaba region; it covers bout 13 kilometers along a oued:

- the upstream area is enclosed in a wide valley flanked by rocky escarpments(Assaba Massive)

  downstream, the palm grove extends into a large plain.

This palm grove suffers from a fairly modest lowering of the oued alluvial aquifer, which is insufficiently replenished by rainfall.

Taka and Wooly Aphids are present, but have not done as much damage as in other palm groves observed.

12. KAMOUR

The Kamour palm grove extends along the Galangali oued valley, on the northeast edge of the Assaba Plateau (a few kilometers downstream from the Diouk Pass).

Certain parts of the grove has become slightly sanded. The level of the alluvial aquifer has lowered slightly since the drought began. Taka and Wooly Aphids affect a small proportion of the palm trees.

13. EL FEYE

This small palm grove is located in the middle of a sandy plain along the Kouroudjel oued. It consists of date palms interwoven with a veritable forest of doum palm (Hyphaenia thebaica).

The alluvial aquifer is well replenished and shallow (about 3 meters below the surface). Shifting dunes fto the north and northwest menace this palm grove.

The presence of Taka and Wooly Aphid was noted on Phoenix dactylifera.

14. KOUROUDJEL

The Kouroudjel palm grove is located about 10 km southwest of El Foye, on the Kouroudjel oued (which flows into the Karakoro)

As for the above palm grove, it is a "doum palm" forest (Hyphaenia thebaica), intermixed with date palms (Phoenix dactylifera). The alluvial aquifer is abundant and near the surface (2 meters below the soil).

The palm grove is not menaced by sand encroachment. Taka and Wooly Aphids are present on some date palms.

15. KANKOSSA

The Kankossa palm grove is located along the Karakoro, on the left bank. This palm grove was planted in 1952 by IFAC, and the trees are geometrically aligned. It is a small palm grove, in very poor condition.

Many palm trees have disappeared because of the lowering of the alluvial aquifer due to drought. and the lack of maintenance.

In addition, these palm trees are affected by Taka and Wooly Aphids.

16. SANI

Located 25 km west of Kankossa, the Sani palm grove occupies an inter-dune depression (Sani Oued) where water is abundant and quite near the surface (often less than one meter).

This is a young, small palm grove, fairly well maintained.

Some trees are affected by Wooly Aphid and Taka.

This palm grove is protected by its geographical location in a depression from drying winds, permitting cultivation of numerous fruit trees (guavas, oranges, lemons, etc.).

17. BARKEWOL

The Barkewol palm grove is located in the Aftout, to the west of the Assaba Massive, along the Barkewol Oued. The soil is heavy, compact and has a high clay content, preventing deep rooting of palm trees. The alluvial aquifer has lowered slightly with the prolonged drought.

This palm grove is quite small.

Water erosion has exposed the base of some palm trees. Taka and Wooly Aphids affect a small number of trees.

3.8.2 SUMMARY OF OBSERVATIONS OF 17 PALM GROVES

PALM GROVES	SAND ENCROACHMENT	DECREASE IN ALLUVIAL AQUIFER LEVEL	INFESTATION BY TAKA AND WOOLY APHID
Moudjeria	Very great	Great	Great
M'Beika	None	None	Present
El Hosseinia	"	"	Present
Niemelane	"	"	Present
Tidjikja	Very great	Great	Present
Rachid	None	Slight	Present
Lahouetat	Very great	Slight	Present
El Kheidia	None	Very great	Very great
Boumdeid	Menace	Great	Present
Kiffa	None	Slight	Present
Guerou	None	Slight	Present
Kamour	Slight	Slight	"
El Foye	Menace	None	"
Kouroudjel	None	None	"
Sani	None	None	"
Kankossa	None	Great	"
Barkewol	None	Slight	"

3.8.2.1. Sand Encroachment

Sand encroachment is a function of the physical milieu and of its human and animal load. Sand encroachment exists when a sandy substratum is present and when human concentrations (due to drought-provoked sedentarization) cause sand remobilization. Examples: Moudjeria and Tidjikja,

where trampling and intense exploitation of vegetable cover have degraded an already fragile milieu.

No serious measures have been undertaken at present to halt the advance of shifting dunes (with the exception of some limited attempts to plant Eurphorbia balsamifera at Boumdeid)

3.8.2.2 Decrease in Alluvial Aquifer Levels of Palm Groves

Alluvial aquifers have lowered in some cases due to insufficient replenishment caused by prolonged rainfall deficits (examples: El Khedia, Moudjeria), added to the presence of concentrations of date palms which draw water from the aquifer through their strong root systems. Sedentarization of large nomad populations and their animals since the drought has increased the demand for water supplies.

In certain cases, such as at Tidjikja, the large number of motor-pumps (more than 50) introduced over recent years has contributed to the lowering of the alluvial aquifer levels. In the Adrar, which was not concerned by this study, the presence of 800 motor-pumps severely affects the aquifer levels.

This mechanization of water-drawing, if it increases in the future, may provoke a dramatic lowering of aquifers (especially in the Adrar).

3.8.2.3 Taka and Wooly Aphids 39/

These parasites are found everywhere and especially menace those palm trees weakened by insuffient water. Since they affect the health

39/ For more information, see "Oasis Sub-Sector Study", LAMS

of the plants, these parasites contribute to the very low level of d production.

In addition, most palm groves suffer from a lack of maintenanc which makes them more vulnerable to the above mentioned parasites.

3.8.2.4 Termites

Termites sometimes attack the trunks of weakened palm trees (e El Khedia, Tidjikja) and thus may contribute to the death of the tre

3.8.2.5 Salinization

Salinization is a secondary problem compared to other degradat phenomena in the palm grove environments studied. Slight salinizati was observed in the Kiffa and Rachid palm groves, but does not appea to affect the growth of palm trees.

On a long term basis, salinization could affect a greater numb of wells used for water-supply to the populations, if alluvial aquif were lowered by the massive introduction of motor-pumps for irrigatic of extended vegetable gardening.

3.9 - GENERAL SUMMARY OF OBSERVATIONS

On the basis of the different field analysis conducted for this study:

- towns and villages
- pastoral wells
- pastures (ranges)
- classified forests
- palm groves

It is apparent that man and his livestock have played a large role in the deterioration of the Mauritanian environment.

The role of the drought is also important; prolonged rainfall deficits have had direct degrading effects on the herbaceous and woody cover, by the following processes:

Delayed leaving of trees, shortened flowering and often, the absence of fruit (especially in 1972-73)

- A certain number of trees died quite simply from lack of water. Geographical location (slopes, dune crests, etc.) may have accentuated water deficits, as the roots were too far away from the humid levels of the soil. The nature of soils is also important.

- For herbaceous cover, annual plants often had their growth stopped before maturity, due to irregular and insufficient rainfall. This resulted in a lack of new seeds and progressive thinning of the grass cover in following years.

<u>However, it is not always easy to separate the actions of the drought from human and animal activities when determining the cause of degradation</u>

When signs of cuttingm branc. breaking, over-grazing and trampling are visible, it is evident that the activities of man and animals are largely responsible for environmental degradation; this is often the case around towns, villages and functioning pastoral wells.

In the Gonakié classified forests of the Senegal River Valley, the abusive actions of man and animals wigh more heavily than the drought as a cause of degradation. Although a great number of trees died due to the absence of floods over several years, the intensification of cutti for wood charcoal is the current reason for the disappearance of the remaining Gonakiés.

However, when trees have withered and grass pastures are reduced in areas far from sedentarization, and where no signs of cutting, branch-breaking, or trampling are visible, it is tempting to attribute degradation directly to the drought. This attribution must be made with caution. For example, in the case of the gum trees (Acacia senegal) most forestry experts having studied these trees in Mauritania attribute their death to prior weakening by man. They feel that the disappearance of this species over vast surface areas (veritable "tree cementaries" in the Trarza) cannot be explained by the drought alone. The brutal methods of exploitation for gum arabic (use of axes, tearing large strips up from the base of the trunk, burning of grass in the gum groves) as well as to feed livestock during the dry season, so weakened the gum trees that they succumbed to subsequent rainfall deficits.

All the other woody species (with the exception of the Gonakié) were less affected by the drought, as demonstrated in the frequency tables given in the preceeding chapters.

As to herbaceous cover, the field observations conducted at the end of the dry season did not permit us to formulate conclusions. While it is certain, that in the immediate surroundings of towns, villages and pastoral wells, the herbaceous cover is seriously damaged by animal concentrations (over-grazing and trampling), it is difficult, given the observation period, to know how other herbaceous pastures were affected by the drought. (The AID Renewable Resources Project, which also concerns the southern third of Mauritania will include agrostological data on the herbaceous cover at the end of the rainy season).

The drought, which contributed greatly to the lowering of the biological potential in this area, broke the fragile equilibrium which formerly existed between the physical milieu and the livestock population which had considerably increased due to a long number of good years and multiple vaccinations.

While this remark is true in general, there exists regional differences as to the extent of the effects of the drought, according to the livestock load and the type of milieu:

- The Southwest (and particularly the Trarza) has had from colonial times a relatively dense well network, causing large animal and nomad concentrations, which were more than the milieu could support. In addition, the Senegalo-Mauritanian sedimentary basin aquifer which feeds most of these wells, has not been greatly affected by the drought.

- The Southeast, isolated from major communications links and possissing a much smaller number of wells (which are not heavily concentrated), has better resisted the prolonged actions of rainfall shortages than the Southwest. A RAMS mission [40] in September 1969, at the end of the rainy season, observed magnificent herbaceous pastures in most of the sandy zones, and denser "aerial" pastures than in the Southwest.

These two examples show the harmful effects of animal concentrations in a fragile milieu, with the following consequences for the environment:

- Disappearance of vegetation cover, compromising livestock raising.
- Soils, especially in sandy milieus, become less fixed and are submitted to increased wind erosion. Dune advancement, wind deflation, sand covers provoke the stripping of the humiferous surface horizons, which support agricultural activities (under appropriate rainfall conditions), etc.

At present, due to the massive sedentarization of the population (mainly nomads) and a part of their livestock, all conditions of environmental degradation can be found around the population centers.

3.9.1 Menaced Zones

We have seen above that there are two major regions as concerns the level of environmental degradation linked to livestock and population concentrations: The Southwest, which has been greatly affected, and the Southeast, which much better preserved.

40/ Mission by the Geographical/Environmental Research Unit.

According to field observations (82 observation sites), it is apparent that finer differentiations exist, as a function of geomorphological units, rainfall, methods of exploiting the milieu, and the population and livestock loads.

The types of degradation which are the most impressive and which have the most devastating effects are found in the formerly fixed dune massives which receive weak average annual rainfall (about 150 to 350 mm):

- Trarza dunes; Brakna dunes; sandy plain (with formerly fixed dunes) between the Assaba, the Tagant and the Affolé; sand border of the Aouker; and the sandy Hodhs plains.

These zones, which are found between 16° and 18° latitude north, include the areas of intense gum tree degradation (see map of gum tree distribution in Annex). Vertiable gum tree cementaries are found, attesting to the intense exploitation in the past. In a preceeding study 41/, we examined the variations of the 150 mm isohyetal line in 1972 (a year of very poor rainfall), as compared to its average position (See surfaces) were particularly affected by the "descent" of the 150 mm isohyetal line towards the south, (in 1972-73 particularly), and thus by severe and prolonged rainfall deficits. The average 150 mm isohyetal line is considered as the northern limit for cattle raising. All categories of livestock were affected by the severity of the drought; many animals

41/ "Major Agro-Ecological zones", Feb. 20, 1980, RAMS

migrated as usual to the north at the end of the rainy season in search of green pasnures; since this was absence, they were forced to eat the meager woody cover of the northern zones. This resulted in major degradation of the vegetable cover in the particular fragile Sahelian zones.

In sandy zones where nomadism and transhumance were once practiced, with extensive livestock raising well-adapted to the fragile Sahel milieu, sedentarization of the population has lead to major remobilization of formerly fixed dnnes (Examples: Boutilimit, Boumdeid, etc.). The remobilized dunes menace housing, wells, arable lowlands and comm nication links

Nothing has yet been done on the national level to prevent dune advancement, except a few modest local attempts which are often destined to fail, given the amplitude of the phenomenon. In the Tagant massives, in the Affolé and on the edge of the Dhar, there are sandy zones under the same latitudes and having the same rainfall, which suffer identical types of degradation:

Examples: Tidjikja, Moudjeria, Tamchakett, Oualata, etc.

1. "Rags" and clayey-sandy plains located between 16 and 18° latitude north and receiving 150 to 350 mm rainfall do not suffer from dune advancement. However, aerial and herbaceous pastures have been greatly affected by drought and animal concentrations as in the previously-cited sand zones. Vegetation has been degraded by rainfall deficits and livestock.

A tendency towards "glazing" of the surface (superficial induration due to deposition filling of fine particles and other processes) is harmful for vegetation. Seeds have difficulty implanting and germinating (both herbaceous and woody species). Wind and water erosion carry off the fine surface particles, baring sterile surfaces. This is particularly the case in the Aftout and the pellite zone of the Hodh.

Examples: Barkewol, El Ghabra, Lahouessi, M'Bout, etc.

The zone represented on the map by variations of the 150 mm isohyetal line in 1972, compared to the normal line, is estimated at 250.000 km2 (see map in Annex).

2. The Senegal River Valley

The Senegal River Valley is a separate zone. It is menaced by the disappearance of its vegetable cover (Oualo Gonakié forests and Diéri mixed forests) because of heavy human concentrations and the increasingly greater demand for wood. The part of the valley located to the south of the Trarza and the Brakna is menaced on a more or less long term basis by the southern advance of dunes, which risk invading the oualo (between Bababé and Keur Macène), which would obviously be catastrophic.

In addition, almost everywhere along the River, the banks are subjected to gulleying and crumbling of their sides, due to the disappearance of the vegetable cover, and heavy concentrations of man (cutting clearing) and animals (grazing, trampling).

3. The Guidimaka

This region is the most populous after the Senegal River Valley zone. It receives an average annual rainfall between 500 and 650 mm. Degradation of the vegetable cover is intense due to heavy animal concentrations (mostly cattle) coming from northern zones (the Tagant) on their way to Mali and Senegal.

Aerial photographs of the Sélibali region show the effects of animal concentrations along the valleys and oued depressions: there are zones of remobilized sands, which appear lighter on the photographs.

The vegetation in the Guidimaka does not appear to have suffered much from the drought but rather from man's actions (clearing for crops, cutting for fire wood, branch breaking to feed livestock) and those of animals (over-grazing, trampling).

4. The Nouakchott-Kiffa Road

This road has provoked intense remobilization of the dunes it crosses in many places, particularly in the Trarza and the Brakna:

- because of the road construction, which perturbed the fixation of surrounding dunes.
- because of human concentrations that have accumulated along the road (villages and nomad camps). The sedentarized populations cut fire zood, break branches for livestock, etc.:

Examples: Sangrafa, Cheggar, Ouad Naga, etc. and recent nomad camps.

The remobilized sands submerge the road. If the process of population settlement along this road continues and increases, it is clear that the road will not be practicable without expensive road clearing using heavy machinery.

This road link will soon reach Tintane and much later Néma. It will cross through sandy plains which are at present relatively well fixed by vegetation (Southeastern zones). It is feared that these sandy zones may remobilize as they are crossed by the road from west to east.

3.9.2 Relatively Well-Preserved Zones

Such zones are located in that part of the southern third of Mauritania (to the east of the Assaba Massive) found below the 450 mm isohyetal line.

These zones have very low population densities per km2 (see Table 1, Chapter 2-1) and the rate of sedentarization is much slower than in the central south and southwest. In the first region (Néma),[42] nomads outnumbered sedentary populations in the 1976-77 census (BCRP IRM). The small number of wells did not provoke excessive animal concentrations before the drought, as occurred in the Southwest.

It is to be feared that the creation of new wells in good pasture lands may cause, in the future, the same situation as in the Trarza unless a rational management policy for pasture lands is instituted at the same time.

42/ See Study "Changements Sociaux, Etude F-1, Le devenir du pastoralisme. Cas de Néma", Sociological Unit. RAMS, 1980.

3.9.3 Exploitation of Wood

Wood exploitation attains its maximum in the Gonakié forests of the Senegal River Valley and around towns and villages. While exploitation of wood exists elsewhere, it is much more scattered. Figures from several studies and reports illustrate the intense forest exploitation to the detriment of the already fragile ecological equilibrium of the Sahel:

The total consumption of wood in Mauritania was estimated by a CILSS team 43/ to be more than 2 750 000 steres per year, including wood charcoal, fire wood, and building wood. The following gives a summary of the results of the CILSS study 44/.

1. Consumption of wood charcoal in urban centers

Urban consumption of wood charcoal is 90 000 tons a year. Another source 45/, cites the consumption of Nouakchott alone at 200 000 kg a day (the equivalent of two 50 kg sacs a month per 3 to 5 member family). Almost all of this wood charcoal comes from the zone along the Senegal River between Rosso and Boghé.

Annual wood charcoal production cited by the Nature Protection service is on the order of 1000 to 1500 tons (figures given by R. Winterbottom). A FAO report in 1975 estimates charcoal production

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43/ and 44/ R. Winterbottom, "Compte Rendu de la Mission Effectuée du 20 au 28 Juillet 1979 à Nouakchott".

45/ John Heermans, Forestry Expert, USAID Consultant. Report of 7/5/1980: "Firewood situation along northern bank of Senegal River between Rosso and Boghé".

at 79 000 tons/year. In 1976, a USAID mission estimated that production would attain 100 000 tons per year. R. Winterbottom (April 18, 1980) estimated that consumption of wood charcoal in urban centers was probably on the order of 135 000 tons per year.

2. Total Consumption[46/]

If we add the consumption of firewood in the rural milieu, Mauritania could consume at present about 1 100 000 tons of wood each year (1 stere : 0.4 ton x 2,750.000 steres : 1,100,000 tons of wood). This consumption is equivalent to the rproduction of 184,000 hectares of irrigated plantations in the river regions (producing 15 stere/ha/year) or 917 000 hectares of village plantations in the interior of the country (producing 3 steres/ha/year).

All these figures show the amplitude of the destruction of the vegetable cover in the southern third of Mauritania by man alone. In these figurescconcerning wood production are not included, of course, destruction caused by clearing for crops, massive branch cutting, the ravages of the drought (on gum trees), over-grazing by livestock and occasional brush fires.

40% of the "wooded surface area" of Mauritania (5.6 million hectares) has been greatly degraded during the current drought.[47/]

46/ R. Winterbottom, March 19-April 14, 1980 - Mission Report, CILSS

47/ Sources: Protection de la Nature, IRM, April 1979, Discussion cited by R. Winterbottom, CILSS Forestry Expert, in the above-cited report.

NOTE: In Chapter 5, we will discuss general proposals for the protection and regeneration of the environment, based on field observations.

3.9.4 Natural Regeneration of Vegetation Cover

We have seen during the different observations (towns/villages, pastoral wells, pastures, classified forests) that natural regeneration occurs for a certain number of woody species, although it is very modest.

However, even a very modest natural regeneration under the presen unfavorable climatic conditions in the southern third of Mauritania is encouraging in terms of possible successful protective measures that cover the undertaken to regenerate the vegetation cover (and the environment) of Mauritania.

All transects were performed in "open" zones, none of which were enclosed in protected fencing; men and animals were observed moving freely, and their various detrimental activities were seen at first hand.

Yet, in spite of livestock, agriculture and cutting, and the harsh climate, some species regenerate.

If certain zones could be efficiently protected from ranging and trampling, cutting, brush fires, etc. it is very probably that the woody and grass cover would regenerate. We cited several examples of zones protected by fencing, where active natural regeneration was observed:

Examples: Boumdeid "l'ancien", around Boutilimit, Aïn Salama, around Kiffa, around Keur Macène, etc.

An experiment in the Adrar, at Atar, conducted a 1953 and 1955 by IFAN (Institut Français d'Afrique Noire) and UNESCO [48] under arid climate conditions (annual average rainfall about 100 mm), is an interesting case to study:

Areas were selected and fenced at different sites, and observed during 3 years and 6 months. After several months, an increase in productivity was observed in the 7 enclosed plots (sheltered from animal and human activities), with "a remarkable rebirth of living vegetation. Woody species especially developed quickly, both in height and width." The herbaceous carpet also became denser.

According to the author of the report, "it has thus been experimentally proven that the actions of man are harmful to vegetation. In many cases, man is the cause of the thinning and even the disappearance of vegetation, especially of woody resources. In addition, the too numerous herds of goats, which continually crop the meager vegetation cover which still exists, undoubtedly lead to the ruin of the country-

[48] Antoine Maegelé, "La protection de la végétation en zone aride", March 23, 1959, IFAN.

side". Even before the present drought, man and animals had a negative impact on vegetation. According to the author, regeneration of the vegetation cover in zones which are efficiently protected occurred fairly rapidly: "a closely cropped pasturem very degraded, can regenerate in less than 5 years, if protected, unless this period is characterized by deficient rainfall".

This example is from a region receiving only about 100 mm annual rainfall; in spite of this meager rainfall, certain species regenerated: Zizyphus lotus, Acacia flava, Maerua crassifolia, Acacia raddiana, Cadaba farinosa, etc.

This study concerns a zone located south of the 150 mm isohyetal line which, in spite of its having suffered prolonged rainfall shortages has shown that part of the vegetation can be regenerated (very modestly), without protection.

3.9.5. Distribution of gum trees and Degradation zones (See Figure 13)

The causes of the disappearance of the gum-trees have already been amply discussed elsewhere in the text.

On the basis of numerous field surveys, questionnaires, transects and talks with nomads and sedentarized populations, a map has been prepared showing the extent of gum trees forests and the main degraded zones.

Northen Limits of Gum Trees

In the southwest (Trarza, Brakna), the gum tree grows a little above $17^{o}30$ latitude north. Going towards the east, the northern limit curves progressively downwards to between 16^{0} and 17° latitude.

This is probably due to the rigorous temperature and the more continental climate (greater evaporation) as one goes inland from the coast.

The gum trees is almost totally absent in the Tagant and Assâba Massives.

Gum tree cementaries were found in the northernmost parts of Acacia senegal distribution, and almost exclusively on sandy surfaces (formerly fixed dunes and large rolling sandy plains).

On rags and clayey-sandy plains located at the same latitudes, the gum trees were much rarer and confined to the most favorable sites. Some were found to be withered, but no hectatomb was discovered.

To the south of the fringe of intensely degraded gum trees, Acacia senegal was found to be better preserved and relatively dense on some old dunes which are still fixed (Examples: around Ould Yengé, sandy zones of the Guidimaka and of the southeast)

Knowledge of the present distribution of the gum tree and its current condition are important given its economic importance. Before

the drought, Acacia senegal furnished substantial revenues to livestock raisers due to the harvest and sale of gum arabic. Our map gives only a general indication of the gum tree situation. It is indispensable that it be completed by a systematic inventory of the existing gum tree groves.

3.9.6 Distribution of Gonakié (Acacia nilotica)

(See Distribution map, Figure 14).

This species is of particular importance due to the excellent wood charcoal it produces.

The disappearance of the Gonakié has already been discussed in detail in Chapter 3-7, "State of Classified Forests".

- At present, the greatest concentration of Gonakiés is along the Senegal River, in Oualo lands, between Gouraye and Keur Macène.
- Elsewhere, Gonakié concentrations were observed along the major oueds: Gorgol, Gorgol Noir, Gorgol Blanc, Karakoro, and Tamourt en Naaj (Tagant).
- The map shows that the Gonakié also exists in other zones, although it is less concentrated: in low lands and tamourts (example: Tamourt Tamchakett) which are temporarily flooded.

In the southwest of Mauritania, the large dune massives of the Trarza and the Brakna are not favorable to the growth of Gonakiés due to the thickness and permeability of the sand, which do not retain surface water long enough to supply the plant.

Only a small zone in the Aftout, between the Brakna and Trarza dunes (prolongation of the Lake R'Kiz depression towards the northeast) possesses a few pools bordered by Gonakiés (example: Weekend Lake 40 km to the southwest of Boutilimit).

4. THEORETICAL ESTIMATE OF LOAD CAPACITY OF PASTURES

Animals still range the Sahel pastures, in spite of the fact that they have been considerably diminished in both quantity and quality by the previously described combinations of drought and the actions of man and animals.

The survey of herbaceous pastures could not be performed for this study, since the surveys were conducted at the end of the dry season. For this reason, the following gives a theoretical estimate of pasture load capacity, based on other documents concerning this subject in the Sahel in general, and in Mauritania in particular.

Another important preliminary remark is necessary: In most literature, "load capacity of pastures" refers to herbaceous pastures only. However, in Mauritania, aerial pastures (trees, shrubs, bushes) constitute, especially during the long dry season, the only food source for sedentary livestock and for most of the other animals not having migrated from Mauritania. Goats, donkeys and camels feed during most of the year on the leaves of different woody species (each animal having its preferred plants) and thus are able to survive.

Therefore, one cannot speak of zero load capacity when only aerial pastures remains.

Cattle (and to a lesser extent, sheep) cannot survive on aerial pasturage alone (one of the causes of the massive zébu hecatomb in Mauritania during the worst drought years).

Studies must be performed on the load capacity of woody pastures, which constitute a vital resource during the dry season for certain types of livestock which are adapted to the rigorous Mauritanian climate.

The vegetation transects we performed (see Transect Summary Sheets in Annex) give the following information about the woody cover:

- height, average spacing, dominant species, cutting, withering.

However, they do not permit, given the absence of biomass field surveys, the determinisation of load capacity of aerial pastures. These data serve only to estimate the degradation of the vegetation cover in the sectors observed.

RAMS Estimations

Let us now examine the data concerning estimates of load capacity of pastures:

A recent study by the RAMS[49/] furnishes estimates on the load capacity of Mauritania pastures, expressed in U. B. T.

49/ Livestock Sub-Sector Study, RAMS - September 1980

(Unité Bétail Tropical")[50/]

Summary results of this study

In Mauritania, a total of 55 million hectares are suitable for pastoral production [51/] and are classified as "pastures".

Most of the herbaceous species growing in these pastures are annual species which can only be exploited during a very limited period (4 to 6 months) by the ruminants.

Production capacity of these pastures varies from one year to the next, as well as their locations, due to the irregular rainfall quantities and distributions (both inter-monthly and inter-annual).

50/ 1 adult camel : 1.00 UBT
1 adult cow : 0.75 UBT
1 adult sheep or goat : 0.15 UBT

Note: UBT values were adopted by the FAO several years ago, but have not been standardized since. Therefore, one must be very cautious when comparing load capacities from different sources.

According to the Manual of Tropical Pastures and Forage Crops, published by the Ministère de la Coopération and the LEMVT (3rd Edition, 1978):

1 UBT : 1 cow of 250 kg at maintenance.

51/ Source: CILSS, Provisional Report, January 1980.

Consequently, the climatic conditions contribute to confine certain categories of livestock to certain areas of the Mauritanian territory 52/

Given the seasonal availability of forage (biomass) and the low load capacities in zones receiving the least rainfall, the only satisfactory production system is based on herd migration (extensive livestock raising).

The load capacity expressed in ha/UBT gives a standard measurement, permitting determination of the following differences:

1. - Forage consumption and feeding habits of different livestock categories (selection of vegetable species).

2. - Biomass produced within pasture zones and between different zones,

3. - Nutritional values of different vegetable species

4. - Weight, sex, age and other variables within a given livestock category.

52/ Distribution maps of cattle, sheeps-goats and camels were developed. They are given in the report on major agro-ecological zones and were reproduced in the LIvestock Subsector report. These maps were adapted from the 3rd Development Plan, 1976-1980 of the Mauritanian Government.

Estimated load capacities in Mauritania go from 4ha/UBT in the extreme south (which receives average annual rainfall of about 650 mm) to 70 ha/UBT for certain areas of the Saharan zone (less than 150 mm rainfall).

The author of the Livestock Subsector Report bases his estimates on both bibliographic research and his long field experience in Sahelian miliers.

This led him to estimate load capacities for all of Mauritania, based on the volume and distribution of rainfall over periods of several years (in ha/UBT), as follows:

- Good rainfall, well distributed 9 - 11 ha/UBT
- Moderate rainfall, adequately distributed 14 - 16 ha/UBT
- Poor rainfall, poorly distributed 19 - 20 ha/UBT

An additional difficulty for the determination of load capacities in Mauritania is that many annual grasses have low nutritional value and when they have dried, they contain excessive cellulose.

In chapter III of the report, the growth of the populations of different livestock categories was estimated up to 1995, using mathematical calculations based on the corelation between gross livestock growth rate and the weighted average of rainfall indexes.

Projection Results Compared to Load Capacities of Pastures in ha/UBT

These results are given in Table III-2, p. 35 of the above-mentioned report; the results are reproduced on Table 34 in this text.

Three hypotheses were employed (see Table 34) :

1. High Estimate : The pastures will be exhausted around 1995, for a load capacity estimated at 9 ha/UBT.

2. Average Estimate : The pastures will be exhausted around 1990 for a load capacity estimated at 14ha/UBT.

3. Low Estimates : The pastures will be exhausted around 1985 for a load capacity estimated at 19 ha/UBT.

4.2 Other Estimates (from other sources) :

Two tables (35 and 36) give estimates of herbaceous pasture load capacity in Mauritania and in the West African Sahel, as a function of soils and corresponding geomorphological units.

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TABLE 34

EXISTING AND PROJECTED LIVESTOCK POPULATIONS, AS A FUNCTION OF THREE HYPOTHESES CONCERNING LOAD CAPACITY OF PASTURES, 1978 TO 2000 (in thousands heads livestock and thousands UBT)

SPECIES/YEAR	1978	1980	1985	1990	2000
1. HIGH ESTIMATE					
Cattle	1,186	1,332	1,782	2,384	
Sheep and goats	7,512	8,282	10,568	13,485	
Camels	782	757	836	923	
Total Livestock	9,426	10,371	13,186	16,792	
Total UBT	2,744	2,998	3,757	4,734	
2. AVERAGE ESTIMATE					
Cattle	1,186	1,271	1,509	1,792	
Sheep and goats	7,512	7,877	8,869	9,985	
Camels	728	745	788	834	
Total Livestock	9,426	9,893	11,166	12,611	
Total UBT	2,744	2,880	3,250	1,676	
3. LOW ESTIMATE					
Cattle	1,186	1,210	1,272		
Sheep and goats	7,512	7,663	8,053		
Camels	728	737	761		
Total Livestock	9,426	9,610	10,086		
Total UBT	2,744	2,794	2,923		

Sources: Banque Centrale de Mauritanie (BCM); Comité Permanent Inter-Etats de lutte contre la sècheresse au Sahel (CILSS); Direction des Etudes et de la Programmation, Aggregat s des Comptes Nationaux, 1978; RAMS estimates.

Table 35 expresses load capacity of pastures in the dry season. It is based on the reference cattle unit, i.e., 1 UBT : 1 cow of 250 kg at maintenance.

These load capacity figures appear optimistic; they do not take into account wasting, trampling or plant preferences of livestock.

TABLE 35

Load Capacity of Pastures During Dry Season

Location of Pastures	HA/Cattle	Ha/UBT
Dunes	4.4	5.9
Interdunes	4	5.3
On thin sands	3	4
Sandy-clayey soils	3.4	4.5
Clayey sandy soils	2.5	3.3
Depressions and talwegs	2.3	3
Gravel Hills	4	5.3
Schisto-sandstone	2.7	3.6
Lithosoils	1 cow	0.75 UBT

Table 36 is more detailed and covers the load capacity of pastures according to rainfall and geomorphological units. It also gives data on:

- biomass (MS. in kg/hectare)
- kilogram/live weight/hectare/year
- number of days/hectare/year in UBT
- number of hectares/year/UBT
- number of hectares in reserve/UBT

(Source : G. Boudet, January 1976).

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TABLE 36: ESTIMATE OF AVERAGE LOAD CAPACITY

	BIOMASS (MS IN KG/ HA)	KG/LIV/HA/ YEAR	DAYS HA/YEAR (UBT)	HA/YEAR/ UBT	HA RESERVE/ UBT (30%)
SUB DESERT SAHEL (150-200 mm)					
dune sands	400	14.5	21	17.2	5.2
sandy silty peneplair	500	18.2	26	13.9	4.2
TYPICAL SAHEL (200-400mm)					
dune sands	1,000	36.4	53	6.9	2.1
sandy peneplain	1,200	43,6	63	5.8	1,7
sandy silty peneplain	2,200	80	115	3.2	0.9
skeletal soils	800	29.1	42	8.7	2.6
Floodland pastures	9,000	-	470	-	-
SAHELO-SOUDANIAN BORDER (400-650 mm)					
dune sands	1,500	54,5	79	4.6	1.4
sandy silty peneplain	1,200	43.6	63	5.8	1.7
silty clayey depressions	3,000	109.1	158	2.3	0.7
Skeletal soils	800	29.1	42	8.7	2.6

Source: Boudet (G) - January 1976 - "Les pâturages sahéliens - Les dangers de dégradation et les possibilités de régénération - Principes de gestion améliorée des parcours sahéliens" - FAO

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According to G. Boudet ("Manuel sur les pâturages tropicaux et les cultures fourragères", 3rd Edition, 1978, Ministry of Cooperation, IEMVT), the subdesert Sahel pastures (150 to 200 mm rainfall) can furnish 20 to 25 days of pasture and about 15 hectares/UBT.

The typical Sahel pastures (200 to 400 mm rainfall) can furnish 55 to 65 days of pasture on sandy soils, 80 days on silty to clayey soils, 40 days on skeletal soils with a load capacity of 9 hectares/UBT, and a regional average of about 7 hectares/UBT.

On the Sahelo-Soudanian border (400 to more than 640 mm rainfall) pastures can dfurnish from 40 to 160 days of pastures per hectare, or 2 to 9 hectares/UBT, with a regional average of about 6 hectares/UBT (which is closer to reality, as agriculture is heavily practiced in this sector).

As concerns floodland pastures, which are prairies of Echinochlo stagnina, the animal load is estimated at 900 pasture days at one UBT, which corresponds to a theoretical load of 0.4 ha/UBT/year and a real load of 0.25 hectares/UBT during the unflooded dry season (7 months).

In the southern third of Mauritanian under consideration, the best pastures are generally found in the sandy zones; these pastures develo on brown-red or brown soils.

Rocky plains and rags of raw mineral soils present only meager aerial pastures.

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As for the lowland soils, while their surface areas are small, they are important pasture resources, since legumes grow in these lands and green vegetation is available for longer periods than in other pastures.

4.3 SUMMARY

The load capacity of pastures varies considerably according to wide number of factors: rainfall, soil types, topography, seasons, category of livestock, livestock plant preferences, etc.

Most often, load capacities are based on estimates. In order to obtain valid figures for Mauritania, it would be useful to conduct practical experiments, by placing different categories of livestock in fenced plots representing different pasture milieus (sandy, rags, lowlands, etc.). Thus, it would be possible over a period of time to evaluate the evolution of herbaceous and woody vegetation as a function of the different animal loads.

These plots should be located at different latitudes under varied average rainfalls throughout Mauritania, in zones of pastoral activities (basically south of the average 150 mm isohyetal line) and agricultural activities (south of the 400 mm isohyetal line).

Given current climate conditions and exploitation of pastures in Mauritania, load capacities for pastures are very low. Only the

lowlands and floodland pastures, which represent a very small surface area, can support a large number of livestock per hectare (about 0.25 hectare/UBT for floodland pastures).

Throughout the southern third of Mauritania, it may be seen that the "pastures" are ranged (especially around towns, villages and pastoral wells) by more livestock than their real load capacity can support. Cattle are the worst affected by this situation and many do not survive, as was seen around Guld Yènge and M'Bout, for example. Urgent measures must be taken by livestock-raising and pasture-management specialists to find a solution to these problems.

5 - Conclusions

This study has identified the principal causes and consequences of environmental deterioration in Mauritania:

Human beings and domestic animals are to a great extent responsible for the constant deterioration of the environment in which they live. The drought, which has diminished biological potential, has broken what had already become a delicate balance between the physical environment (water, soils, vegetation, etc.) and humar activities.

The consequences of this disrupted equilibrium threaten the future of rural life in Mauritania.

The following topics will be treated in this chapter:

- specific zones and their characteristics;
- the attitudes of rural people towards their environment;
- the regeneration process of vegetation;
- the lack of available means to stop desertification.

Recommendations will be presented in the last chapter of this study.

5-1 The Identified Zones and their Characteristics

A certain number of zones showing specific kinds of nvironmental deterioration has been identified and classiied by the seriousness and type of threat, both to the natural environment and to the future of rural Mauritanians, most of whom have become sedentary since the start of the drought.

There are two main categories of zones:

1. Threatened zones.
3. Zones that are still relatively well-preserved

A. The Threatened Zones:

The threatened zones can be subdivided into six categories according to physical elements and types of environmental use. These are:

1. Dune areas and sandy peneplains.
2. The Nouakchott-Kiffa-Néma road corridor.
3. Palm groves.
4. Rags and sandy clayey peneplains.
5. The Senegal River Valley.
6. Guidimakha.

1. The Dune and Sandy Peneplain Regions

These are particularly fragile regions where the effects of deterioration are quite stark. These effects are evident either in the form of line dunes, which are old dunes that have become mobile again, or recent accumulations of wind-blown sand resulting from the disappearance of the vegetation that once protected and stabilized the soils.

The consequences of this kind of environmental degradation are most keenly felt around towns and villages (e.g. Boutilimit, Bareïna, Choggar, etc.).

- Houses are buried or overturned by moving sands; existing infrastructure - wells, roads, etc., are gradually buried.

a) Trarza and part of Brakna are the regions most affected by these phenomena, according to observations made for this study: most of the areas of Mauritania that are threatened by dunes are in these regions.

- Old ogolian dunes, formerly stabilized, are again becoming active over wide areas, particularly around areas of sedentarization: Boutilimit and its environs

are a typical case of desertification caused by human activities leading to extensive dune remobilization (see aerial photographs).

Because of a high concentration of wells in these regions for historic and socio-economic reasons) vegetation has been severely affected by overgrazing in the dune areas of Trarza and Brakna. The gumtree has disappeared from vast stretches of land that have been stricken by the drought as well as by intensive cutting before the drought (veritable "tree cementeries" can be seen especially between Boutilimit, R'Kiz and Mederdra).

b. Other zones where the same kinds of deterioration (although to a lesser extent) are visible include:

- The sandy peneplains of Assaba: areas around Kiffa and Boumdeid.
- The sandy peneplains of Hodh al Gharbi: the edge of the sands of Aouker, the Tamchakett area, Aïoun el Atrouss, Koboni.
- The sandy peneplains of Hodh al Chargui: the edge of the sands of Aouker, Timbedra and Oualata areas.

2. The Nouakchott-Kiffa-Néma Road Corridor

The new paved road ("The Road of Hope" - la "Route de l'Espoir") is causing environmental deterioration characterized by renewed dune activity or sand movements in whatever sandy region it crosses:

- At first, the construction work breaks up the soil physically, which is followed by the destruction of the vegetation alongside the road by farming or grazing as people progressively settle there. Trampling and over-

grazing by animals also destabilize sand that was once ferm.

This corridor is soon to reach Aïoun el Atrouss, Timbédra and Néma. It will traverse sandy areas (pene-plains and dunes) which are still relatively well stabilized by vegetation (in the south-eastern area). It is probable that the sand formations which are to be cut through by the road will themselves become active, with all the harmful consequences that this implies.

Palm Groves

The vast majority palm groves is located in sandy adi valleys in the heart of sandstone massifs or their mmediate fringes: Tagant, Assaba, Affolé (the most mportant date-growing region in Mauritania, Adrar is ocated outside of the Southern Third, in the Sahara).

A large number of groves is in danger of being nvaded by sand; in some places, as in Moudjéria, idjikja and Chinguetti (in Adrar, outside of the area eing studied here), the situation is catastrophic: he date palms are being buried under tons of moving sand s are dwellings in nearby settlements. The oases suffer rom several other major problems:

- fluctuation of the alluvial watertables (already shrunken by prolonged deficits of rainfall), and worsened by untimely use of motor-driven pumps can lead to the weakening and even the death of the date palms, increased salinization of water sources and a disappearance over time of the oases, whose survival depends on these alluvial watertables.

grayscale and the "taka", or date palm spider mite (Olygonychus afrasiaticus, or Mogregor), attack trees that have already been weakened by water deficits (e.g. Khoudia, in Tagant).

4. Rags and Clayey-Sandy Peneplains

These geomorphological units are suffering from:
- wind deflation
- water erosion
- hardening of soil surface by crust formation (glaçage).

The drought plus human activities - herding, agriculture, land clearing and tree cutting have gradually exposed the soil, making it vulnerable to the kinds of degradation just mentioned. All of this is extremely harmful to vegetation: in fact, it becomes very difficult for seeds to lodge in a place where they can germinate. This is true for trees as well as for grasses and seriously jeopardizes chances for natural regeneration. The Aftout and the Pellite areas of the Hodh are the regions that are the most seriously affected.

Phenomena of environmental deterioration are of even greater importance around towns and villages located in these zones: e.g. M'Bout, Barkéwol, El Ghabra, Sanouessi, etc...

5. The Senegal River Valley

This is the most populous zone of Mauritania and is threatened by the disappearance of its vegetation
- gonakier forests in walo areas, mixed forests in fondé and diéri areas - because of evergrowing needs of the people (this is an area of rapid population increase)
- charcoal burning, firewood cutting, lumbering, clearing land for crops, grazing, etc...

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The results of this intensive exploitation of the environment are manifested by:

- marked water erosion of cultivated soils, with numerous ravines; caving in of the banks of the Senegal River.
- a more or less long term threat to the valley of invasion by the dunes located to the north, particularly between Keur Macène and Bababé (southern Trarza and Brakna) if the disappearance of vegetation continues. All of this bodes ill for the future if nothing is done to improve the situation.

6. Guidimakha

This is the most populous region of Mauritania, after the Senegal River Valley. Most inhabitants are Soninké farmers. Guidimakha is also suffering from a serious deterioration of its vegetation due to the density of its population, to clearing of land for crops (it is the most important area of rainfed agriculture in Mauritania), to high concentrations of grazing animals which either live in the region or transit through it on their way from the north towards Mali or Senegal.

All of these factors contribute to a marked thinning of the vegetation which results in:

- the exposure of soils to water erosion and wind deflation and the ensuing appearance of surface sand covers. Certain sandy zones along wadis become active again;
- hardening-related phenomena appearing on clayey-sandy surfaces.

As in the other zones, deterioration is noticeably worse around towns and villages.

B. Areas that Are Still Relatively Well-Preserved

1. The South-East:

On the whole, the southern part of southeastern Mauritania still has a covering of vegetation that is adequate for the reasons cited in chapter 3-9.
General summary of facts:

- low population density per square kilometer;
- few pastoral wells;
- a population that is still largely nomadic, especially in the First Region.

2. Other Zones

In the regions threatened by environmental deterioration, there are still preserved areas located in the south-central and south-western parts of the country. The vegetation transects undertaken for this study give information on some of these zones (particularly pasture lands). These zones usually have few or no inhabitants and lie far from human activities.

5-2 The Attitudes of the People towards their Environment

Rural Mauritanians are aware of the general deterioration of the environment and its effects on their daily life. However, confronted by an overwhelmingly vast problem, the people are rather disconcerted. An unfortunately small number of groups or communities has understood the harmful role of men and grazing animals in worsening the process of on-going deterioration already accentuated by chronic deficits in rainfall and has taken any measures producing positive results. The best-known case is that of Boumdeid, in Assaba, where an extensive area has been fenced off with

branches (zeribas) and in which all cutting and grazing are forbidden. At Aïn Salama, in Trarza, the village chief has forbidden the cutting of green wood. In both cases, results are encouraging.

Sometimes, as in Charatt, in Trarza, a few hesitant efforts to stabilize dunes with Euphorbia balsamifera have been made, but without any technical support; this kind of activity is often destined to fail. It is surprising to find, however, that in the overwhelming majority of cases, no local initiative of any kind is ever taken to fight desertification.

Various reasons:

1) Herders

Herders are not aware that they contribute to desertification and believe that the phenomenon is purely climatic. From their fatalistic point of view, the drought is due to divine causes.

They often maintain very large herds, which is scarcely compatible with available vegetation resources and intense overgrazing results. In addition, massive cutting down of tree branches to feed the animals progressively weakens the trees which have survived the drought. It must be noted, however, that herding practices are quite different among Moors and Peulhs:

- the Moors more often have "employees" to take care of their herds, who merely "accompany" the animals.
- the Peulhs lead their family herds themselves and constantly move about looking for new pastures. They guide the animals and thus exert less pressure on their milieu. In addition, they take much better care of their animals because they own them.

(It must not be forgotten that herds are considered more a source of monetary income by Moors whereas the animals have an affective and prestige value among Peulhs.)

2) Farmers

Farmers are largely unaware that extensive agriculture contributes considerably to water and wind erosion by exposing formerly wooded areas to the elements. They do not have the technical knowledge or skills that would allow them to practise a more appropriate kind of agriculture and they merely perpetuate ancestral skills. Furthermore, in order to protect their crops, they put up zeribas by cutting down tree branches. They justify this practice because without it, animals would decimate their crops.

3) Needs

Since the majority of the population has become sedentary, problems of fuel supply are becoming more and more serious, especially in cities and villages. The people, who need firewood at all costs to prepare their food, are obliged to cut down trees because dead wood is becoming increasingly rare around settlements. Their attitude is dictated by necessity of survival: they do not now have the means of using costly substitute fuels such as kerosene or gas, which are sold in stores. The people are forced to use natural environing vegetation without taking into account the resulting deterioration of the environment, even though all cutting of green wood is officially forbidden.

4) Speculation

The exploitation of the gonakier forests along the Senegal River for charcoal burning is a profit-making

business that has taken on alarming proportions: in effect, within 5 or 6 years, the classified forests of the valley will have completely disappeared if the present rate of cutting is maintained and if nothing is done to conserve this resource, which is indispensible to the ecological balance of the Chemama.

On-site research for this study showed how extensive this charcoal burning business has become, in spite of its harmful effects on the environment. The Environmental Protection Department (Direction de la Protection de la Nature) is quite overwhelmed, especially between Rosso and Boghé, by the number of infractions, as evidenced by the numerous charcoal ovens observed, most of which were in use. The local people's involvement in this affair is not very clear and one wonders who is really behind it. The charcoal is produced mainly to supply the larger cities: Nouakchott, Nouadhibou, Atar, Rosso, etc.

5-3 The Process of Vegetation Regeneration

In most parts of the Southern Third of Mauritania, there is a certain natural regeneration of woody vegetation in progress: there is not much around cities, villages and water sources, but there is noticeably more the farther one goes from these places.

This natural regeneration is very encouraging for the future even though it is still very modest: it shows that even under present drought conditions, certain species can regenerate, either by sending out new shoots from the stump, as in the case of Balanites aegyptica, or by germination of seeds among species like Acacia raddiana and Acacia senegal, for example.

Sandy areas are the most favorable areas for this kind of regeneration because seeds can lodge themselves and germinate without difficulty as soon as there is enough rainfall.

In the case of clayey to sandy-clayey soils and rags, the surface of the soil is easily hardened and does not lend itself to the germination of seeds.

The main factors preventing natural regeneration are overgrazing and trampling by herds of animals, as well as bush fires, in the southern part of the country.

The presence of many sedentary grazing animals around cities and villages in addition to human actions such as cutting, trampling and land clearing, prevent any significant regeneration of vegetation in these areas.

5-4 The Inadequacy of Available Means to Fight Desertification

1) Based on observations made for this study, it can be concluded that the government is not able to control human activity leading to steady environmental deterioration.

2) No far-reaching, coordinated and planned action has yet been undertaken by the government to fight desertification

3) The budget of the Ministry of Rural Development reflects the inadequacy of resources allocated to its sector: in the 1979 governmental budget, rural development was allocated 135,900,000 UM, which was equal to half of the education budget and one third of the health budget. The rural development budget is equal to less than one sixth of the amortization of the public debt of the government's operating budget. Foreign assistance received by Mauritania is equal to about $ 150,000,000 (US) per year, or 50 times

the 1979 rural development budget (53). The new budget for the Ministry of Rural Development for 1981 has just been approved and it amounts to only 1.61% of the national budget (54). The budget of the Environmental Protection Department, which is part of the Ministry of Rural Development, is equal to only 0.26% of the national budget (that is, 27,411,000 UM) and 16% of the budget of its own Ministry.

4) The present structure of the Environmental Protection Department and its financial means prevent it from playing the role it was intended to play: that is, a service concerned with environmental management, regulation and protection as well as rural education and training.

5) Several examples highlight the inadequacy of this service, which nevertheless has a primordial role to play Mauritania's fight against desertification:

- No large-scale reforestation has been accomplished within the past 20 years either in the classified forests or in any other sector.
- No experimentation with natural regeneration on any scale has ever been carried out by the service since its creation.

(53) According to the FAO mission report: "Lutte contre la désertification-Mauritanie" by Michel Baumer and Mahmoud Sabra, Rome, June, 1980.

(54) Source: Ministry of the Economy and Finances, Department of Studies and Programs, 1981.

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- No dune stabilization activities have been tried since the experiment at Mederdra undertaken some time ago by the Forestry Service (Eaux et Forêts), even though dune remobilization is one of the most dramatic aspects of environmental deterioration.
- No conservation measures have been undertaken along the "Route de l'Espoir".
- No revisions or adaptations have been made of the Code Forestier (Forest Code) which dates back to July 4, 1935.

It would take a long time to draw up a complete list of problems.

6) One of the Environmental Protection Department's most important positive achievements is the creation of 4,800 km fire breaks between 1976 and 1980 with the collaboration of the Livestock Service in the following regions: Gorgol (1,000 km), Brakna (1,000 km), Assaba (900 km), Trarza (1,000 km), Hodh el Chargui (500 km) and Hodh el Gharbi (400 km).

7) It must be noted that the Environmental Protection Service has played a largely repressive role to date vis-a-vi rural people, who do not always understand the infractions for which they are punished. The Department's educational role is neglected.

8) There had been no evidence of any real political will to activate the necessary means to fight against desertification in Mauritania until the Seminar for Drawing Up a National Mobilization Plan to Fight against the Drought, chaired by the Minister of Rural Development, was held in Nouakchott from May 26 to 28, 1980. This new orientation shows the degree to which an awareness of the catastrophic situation of the environment had dawned and led to a firm resolve on the part of the government to do everything

possible from then on to save the country from the threat of desertification by giving priority to improving the rural sector, so long neglected in the past.

9) Nevertheless, the new budget that was recently approved for 1981 gives but a small percent to the Ministry of Rural Development and to the Environmental Protection Service (1.6 and 0.26% of the national budget respectively). These new budgets do not seem adequate to provide the means to fight desertification in Mauritania, in spite of the recommendations of the Seminar for Drawing Up a National Mobilization Plan to Fight Against the Drought.

6 - Recommendations

Numerous proposals and recommendations were drawn up during the above-mentioned seminar and are contained in a final document (not analyzed here) entitled "Conclusions and Recommendations".

The recommendations in this report are derived from the research in the Southern Third of Mauritania on which the report is based. These recommendations concern:

1) The role of the Mauritanian government in the fight against desertification.
2) Specific actions to be taken in the zones identified in this study.
3) The creation of a true environmental code.

6-1 The Role of the Government

The government should be the main promoter of the protection and regeneration of the environment in Mauritania. It will have to mobilize effective means for rehabilitating and conserving the environment and take into account the

fact that exceptional solutions are demanded by a situation of such gravity. Since the factors in the problem of desertification are complex and changing, it is necessary to be imaginative and flexible in the decisions to be taken. In effect, there is a veritable mosaic of particular situations composed of unique local human, physical and climatic factors as well as effects of environment use.

As far as possible, a maximum number of decisions and actions concerning policy must be undertaken on the regional level (regions must have a certain autonomy because decisions made in Nouakchott alone are too centralized and too far from local realities to be effective and operational (due especially to bureaucratic slowness). As the Environmental Protection Service has suggested (55), it is necessary to create coordinating structures in the domain of anti-desertification efforts:

- a close collaboration must be assured both on the central and on the regional levels (which is not now the case);
- a National Comm ttee for the Fight Against Desertification, chaired by the Head of State, must be created;
- Regional Committees for the Fight Against Desertification chaired by the Governors themselves must be created. Assistant governors, prefects and regional service heads as well as community representatives are to be closely associated with the work of these committees.

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(55) 4-Year Plan (Plan Quadriennal) 1981-85 - Rapport général.

The various analyses based upon direct observations made for this study indicate clearly that the government exercises but little control in terms of managing and protecting the environment:

- The people make anarchic use of vegetation, soil and water resources (alluvial watertables in particular).
- On the whole the environment receives little or no respect. The reasons for these attitudes are varied, as seen earlier.
- The massive sedentarization of people in cities and villages only heightens the problems of deterioration. Thus, the environment progressively deteriorates while no conservation measures equal to the seriousness of the problem have been undertaken so far.

It is therefore urgent to change all this in the interest of the nation and the future well-being of rural people before the situation becomes irreversible.

6-2 Specific Actions to be taken in the Zones Identified by This Study

In the Southern Third of Mauritania, 6 zones where the environment is particularly threatened have been identified. The existence of still relatively well-preserved zones has also been indicated (cf. Conclusion, Chapter 5-1).

In each of these zones, specific actions must be undertaken according to the kinds of prevalent problems. The following actions are recommended:

A. Threatened Zones

Priority must be given to actions in these areas. The worst problem is, without a doubt, that of dune remobilization, which touches numerous economic sectors nation-wide and hinders infrastructure use.

1) Dune areas and sandy peneplains:

The most critical problem is, beyond any doubt, that of towns and villages whose very existence is threatened by shifting dunes; every effort must be made to stop old dunes from becoming remobilized. The following steps must be taken:

a) Stopping the dunes by mechanical means: public works equipment can be used to push back the most menacing dunes and remove the tons of sand that are smothering dwellings. This, of course, is an action to be done when there are no other solutions; it would certainly require government help in the form of equipment.

b) In areas where dunes have not yet invaded living or productive areas, or where they have been pushed back some distance by equipment, stabilization must be carried out by combining over time the use of physical obstacles, such as pieces of wood, branches, Calothropis procera stakes, etc. - and vegetation (for example, Euphorbia balsamifera, Septadenia spartium, etc.). In order to succeed, these activities require initial supervision by a qualified person. Later on, villages themselves can carry on the activities.

c) In cases where the dunes are not yet active, but where vegetation is seriously deteriorated or sparse, preventive measures must be taken around settlements:

- putting fragile areas off limits (by using fencing or forbidding entry) in order to favor natural regeneration;
- reforestation can be done if it is necessary to protect sandy soils.

d) As for the wide areas of grazing lands, improved methods of management are necessary:

- extensive areas could be placed off limits in order to encourage natural regeneration of vegetation;
- reforestation efforts are expensive and can hardly cover vast areas;
- the areas around pastoral wells should receive specific kind of improvement.

2) The Nouakchott-Kiffa-Néma Road Corridor

Measures must be taken quickly in order to:

- stabilize by appropriate methods the dunes which are already mobile and are invading the road corridor (combined use of vegetation and material means);
- prevent the remobilization of dune areas - it would be desirable to control as much as possible the present anarchic growth of settlements along the road corridor through the following measures:
  - allow building on the downwind side of the road so that if the sand becomes mobile again, it does not cover the road.
  - encourage settlements at a good distance from the road, and, if possible, on sites where vegetation is still well preserved.

Studies should be undertaken by the public works department in order to study in greater detail present and future impact of road-building on the environment and to suggest measures to be taken.
Particular attention must be given to the danger to sandy areas which the road is to cross.

) Palm Groves

Measures should be taken to:

- save the groves, which are now being invaded by sand (ex: Tidjikja, Moudjéria, Chinguetti, etc.);
- control the use of alluvial watertables on which the very existence of the groves depends.

(Other measures, based on greater specialization in agronomy, are examined in the Study on the Oasis Sub-sector).

a) Invasion by Dunes:

The recommendations are the same as those cited previously for dune regions and sandy peneplains: mechanical means in the worst cases; stabilization and protection in order to stimulate natural regeneration, reforestation.

b) Use of Alluvial Water Tables

The fragile alluvial watertables in wadis must be used rationally, especially in view of the present drought. An uncontrolled increase in the use of motor pumps may exhaust them if they go beyond the ability of a watertable to renew itself.

Basic Recommendations:

There is an urgent need to facilitate the replenishing of alluvial watertables by creating dams on the surface or underground; in either case, they are generally very effective, because by retaining run-off, they allow better vertical infiltration of water into the alluvia and therefore an increased storage of water. At present, large quantities of water are lost downstream and are thus unavailable to the needs of plants, men and their animals.

Specific studies are to be undertaken by the Hydraulic Service in order to assess the volumes of water in alluvial watertables in terms of rainfall, present reserves and future reserves that could be created by the use of feeder dams: this would permit the use of alluvial watertables in palm groves according to the actual potential of the water resources.

4) Rags and Clayey-Sandy Peneplains

Measures should be taken in order to:

- restore soils whose surface has been hardened, in order to stop water erosion and wind deflation; by breaking the surface crust of hardened soils, vegetation can gradually re-establish itself (as shown by several spectacularly successful experiments in the Sahel). In order to do this, animal traction could be used: it would suffice to pull along a kind of scraper sufficiently heavy to penetrate the surface. The results are rapid. This solution obviously cannot be applied to immense areas, but could concern the areas with the greatest need: the perimeters of cities and villages, cultivated areas, pastoral wells, etc. other measures could be taken simultaneously: reforestation, groundcover plants, contour planting, etc.
- This could be carried out over a limited area because of the resources required for it. For wider areas, setting deteriorated areas off limits seems to be a realistic solution. This would encourage the natural regeneration of vegetation and is less difficult and constraining than large scale reforestation. A better management of trek routes must be created.

Dam sites (which are numerous in the Aftout area) should be protected from being silted up: appropriate measures should be taken after studying the requirements of each case.

5) The Senegal River Valley

Given the seriousness of the dangers menacing this important agricultural zone, it is imperative to take vigorous measures to re-establish the ecological equilibrium of the valley. First of all, all wood use should be rigorously controlled (charcoal burning, various kinds of cutting). The classified forests must be put entirely off limits in order to preserve what is left of them; massive reforestation must be undertaken in order to restore them to their original extent and density; natural regeneration efforts are also recommended.

It must be emphasized that this undertaking should be accomplished in collaboration with the OMVS, taking into account the forests which will disappear following the construction of the Diama and Manantali Dams.

- The mixed forests in fondé and dieri areas must be protected in order to promote natural regeneration. Furthermore, large scale reforestation is needed.
- Land clearing for cultivation must be controlled: it is now widespread and destructive, exposing vast areas.
- Irrigated fields must be protected from the wind by planting wind breaks (which will at the same time provide firewood to the local people, thereby helping to spare the gonakier forests which are now much valued).
- All these measures will contribute to protecting the valley as a whole and halt water erosion, which now causes much damage.

- Other initiatives aimed at preventing the remobilization of the dunes located immediately north of the valley (between Keur Macène and Boghé) must be taken because their penetration of the walo lands along the river would be disastrous for all kinds of agricultural activities. In this regard, the forests of the valley are to act as a protective screen.

5. Guidimakha

- The problems of deterioration there are also numerous:
- Bush fires require the creation and maintenance of fire-breaks.
- The heavy concentration of herds is extremely damaging to the vegetation and the soil and requires appropriate solutions: putting off limits and improving the management of trek routes, for example.
- The possibilities of natural regeneration are significant in view of the region's rainfall (400 to 650 mm); but overgrazing and trampling make regeneration difficult.
- Land clearing for crops must be controlled and be done through more appropriate methods that are less destructive to the environment.

B. Zones that Are Still Relatively Well-Preserved

For these zones as a whole, several precautions are recommended.

1. The South-East

All new wells must be part of a prior planning process to take into account:

- the carrying capacity of the pastures;
- the prior creation of management for new pastures to be used.

2. Other Zones

These must be counted and protected: many of them are in the middle of deteriorated zones - the un-damaged vegetation can play a role in restoring the deteriorated lands thanks to the stock of seeds that they contain - these zones are thus true biological reserves that must be protected.

6-3 Towards the Establishment of an Environmental Code

In light of the preceding remarks, it seems highly desirable to set up a true Environmental code concerning the whole range of activities in the rural sector (and not only forest areas). This code should:

- define steps to be taken in the fight against desertification and must absolutely include:
  1) A general plan of action concerning the regeneration of vegetation and the rehabilitation of damaged soils, including the programs proposed above.
  2) A general plan of action for the conservation of soils, vegetation and water resources.
  3) The preparation of impact studies to be undertaken before implementing all projects in the rural sector.

This Environmental code would establish favorable conditions for the rational management of natural renewable resources and would guarantee the preservation of the national heritage. It would also establish decentralized modes of action focused on the local community level, ranging from the village or city level to the central governmental level, and would emphasize certain basic recommendations:

- The greatest effort should be given to training and sensitizing rural communities, because it is they who are

closest to the daily realities of the Mauritanian environment. Demonstration activities should be undertaken, such as dune stabilization, reforestation, restoration of eroded soils, regeneration of trek routes, etc.

As far as possible, and according to the particular needs of each case, these actions should be based on simple techniques using local materials: wood, stone, clay, etc. Labor would be supplied by the farmers and herders themselves.

Supervision will be necessary in the beginning; it would be phased out as techniques were assimilated and satisfying results produced. It is important that supervision be done by sufficiently prepared trainers who are able to carry out this work; if not, the risk of frequent failure will be a danger. Any failure could ultimately endanger regional anti-desertification programs by creating through a negative psychological impact on the local people.

- Government support of various kinds could be given to the rural communities that show the most initiative and motivation; it is up to the Mauritanian authorities to establish the modes of making this assistance available.

The Environmental Code should concern all rural sector activities:

-herding,
-irrigated agriculture,
-rain-fed agriculture,
-oases (palm groves), and
-fishing

and be the focus of an integrated approach touching on the sociological, economic and financial, technical and administrative aspects of the anti-desertification program.

This Environmental code would in fact be a powerful planning tool by virtue of its theoretical and practical advice.

It would be advisable to link the code to five aspects of the Mauritanian environment:

- Water
- Pastures
- Soils
- Forests
- Towns and villages

Basic Reasons:

1) Water is the fundamental resource; without it, nothing can be done: it must therefore be used sparingly in the existing drought conditions of Mauritania.

2) Pastures are at the same time a source of food for grazing animals and a soil stabilizer.

3) Soils are the basic support of all agricultural, forestry and herding activities and must therefore receive maximum attention.

4) Forests, which effectively protect the soil, are the principal fuel resource in the country. They also meet basic human needs by providing wood, fruit and seed pods. This study has shown how deteriorated the forests have become.

5) Towns and villages are particularly concerned by all aspects of environmental deterioration. Their very survival is a function of the above-mentioned resources.

In conclusion, it must be said that without the prior elaboration of clear and coherent sectoral policies, the struggle against desertification can scarcely be effective; furthermore, only an integrated approach to implementing the appropriate means for this struggle can bear fruit.

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Ministry of Economy and Finance

Directorate of Studies and Programming

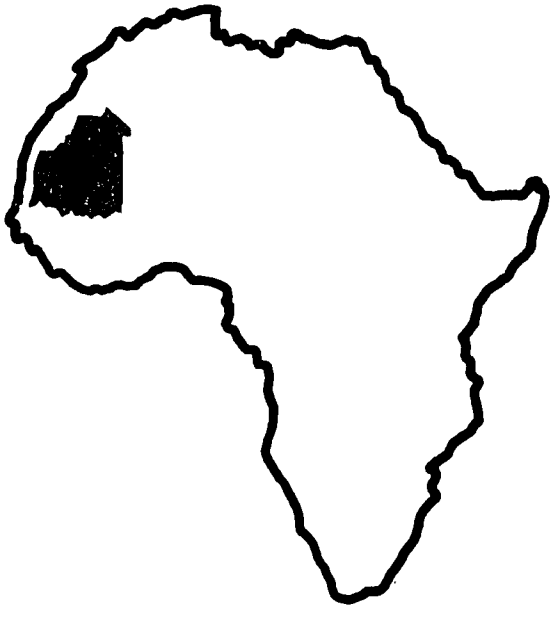
RAMS PROJECT

Rural Assessment and Manpower Surveys

Environmental Regeneration of
Southern Third of Mauritania

Appendices

AS - 2



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Louis Berger International, Inc., East Orange, New Jersey 07019
Action Programs International, Santa Monica, California 90406

1980

Annexe I

Appendix I

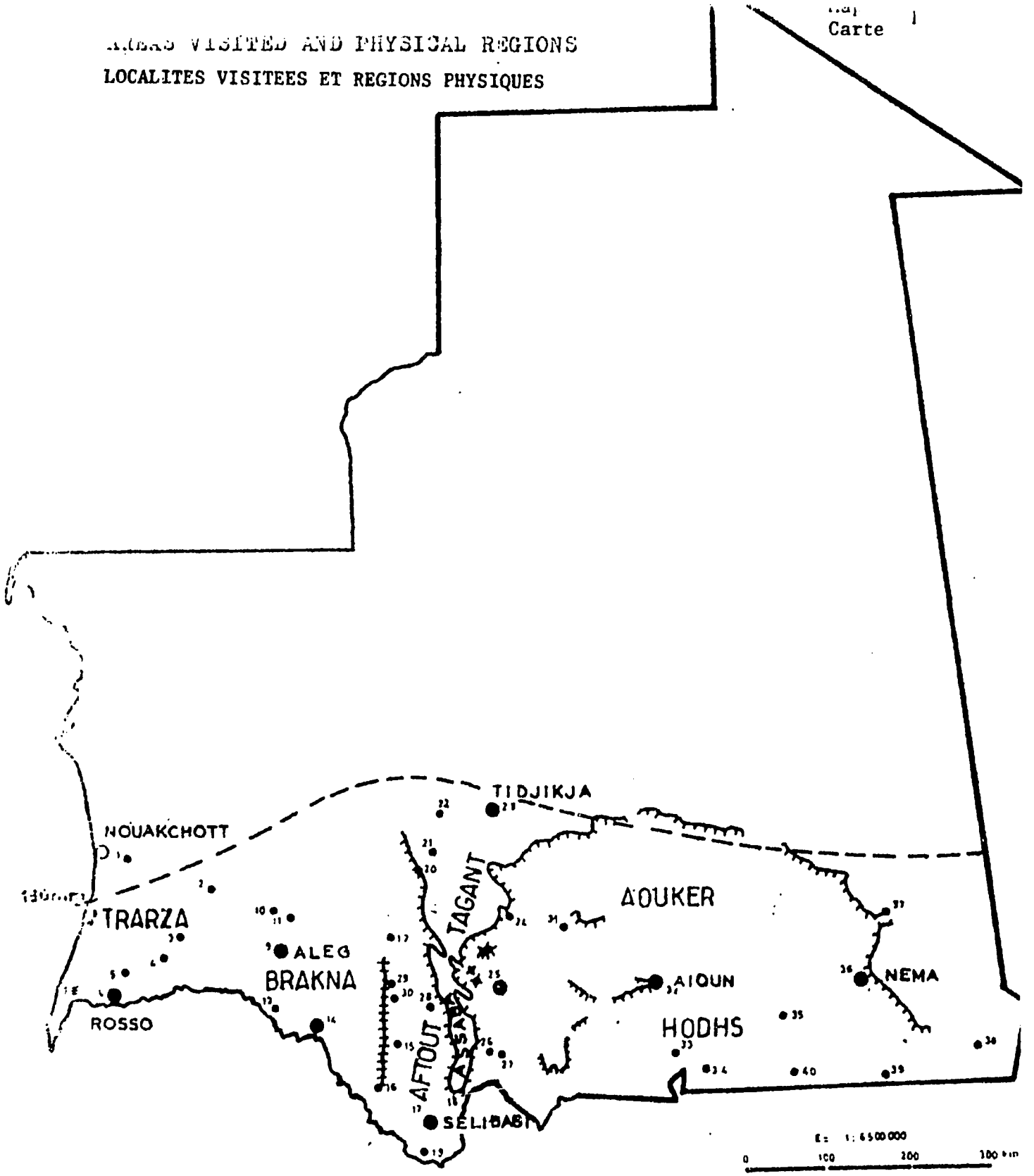
Cartes

Maps

N.B. Les Figures 9 à 14 sont inclues dans le texte du rapport.
The Figures 9 to 14 are included in the text of the report.

Map 1
Carte

AREAS VISITED AND PHYSICAL REGIONS
LOCALITES VISITEES ET REGIONS PHYSIQUES



Visited towns - Villes visitées ●

Visited villages - Villages visités •

Escarpments - Escarpements

Isohyet - Isohyète

Apalachian - Apalacien

: RAMS 1980.

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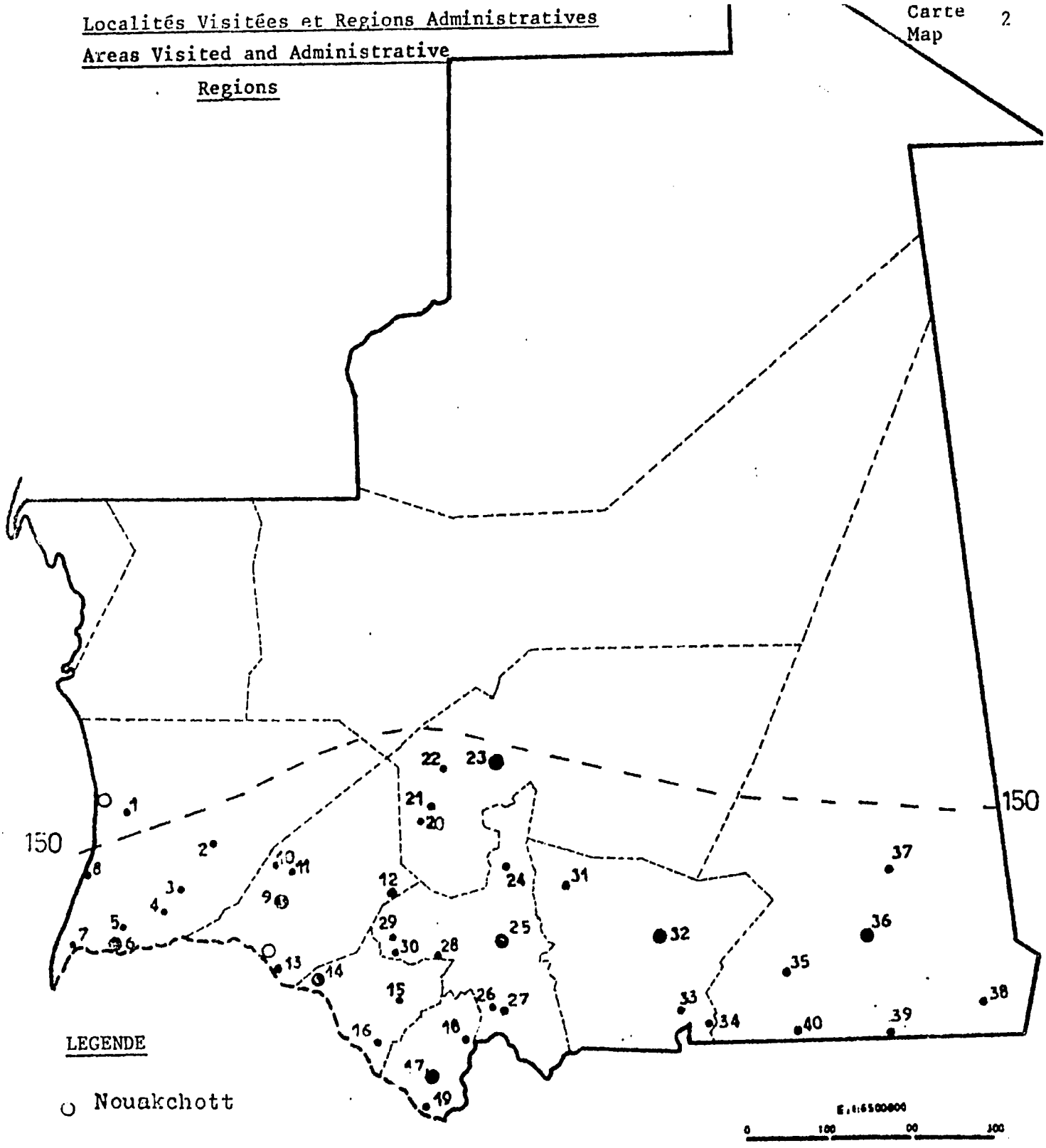
Localités Visitées et Regions Administratives

Areas Visited and Administrative Regions

Carte 2
Map



LEGENDE

○ Nouakchott

● Ville — Town

• Village — Village

--------- Limite régionale — Regional limit

------- Isohyète 150 mm — Isohyet 150 mm

------- Fleuve Sénégal — Senegal River

SOURCE: RAMS 1980.

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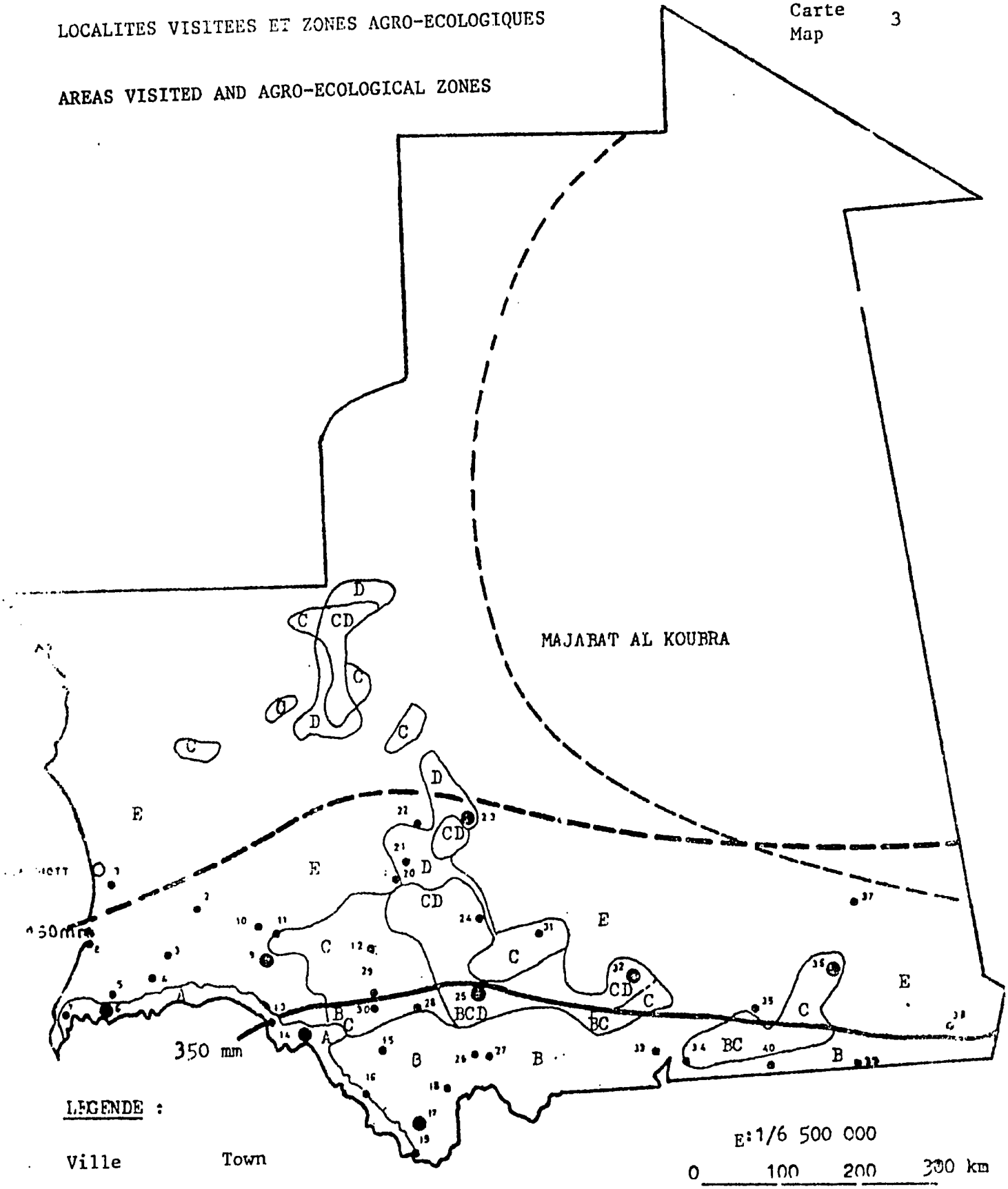
LOCALITES VISITEES ET ZONES AGRO-ECOLOGIQUES

AREAS VISITED AND AGRO-ECOLOGICAL ZONES

Carte 3
Map



LEGENDE :

Ville Town

Chef-lieu de région
Regional headquarters

Limite de zone agro-écologiques
Agro-ecological zone limit

Limite de la Majabat Al Koubra
Limit of the Majabat Al Koubra

Isohyet 150 mm Isohyet 150 mm

Isohyet 350 mm Isohyet 350 mm

A - Vallée alluviale du fleuve Sénégal
Alluviale Valley of Senegal River

B - Cultures sous pluies
Rainfed agriculture

C - Cultures de décrue des oueds
Recessional agriculture in wadi

D - Palmeraies
Palm groves

E - Pastorale
Pasture area

SOURCE: Auteur RAMS 1980. Author, RAMS 1980

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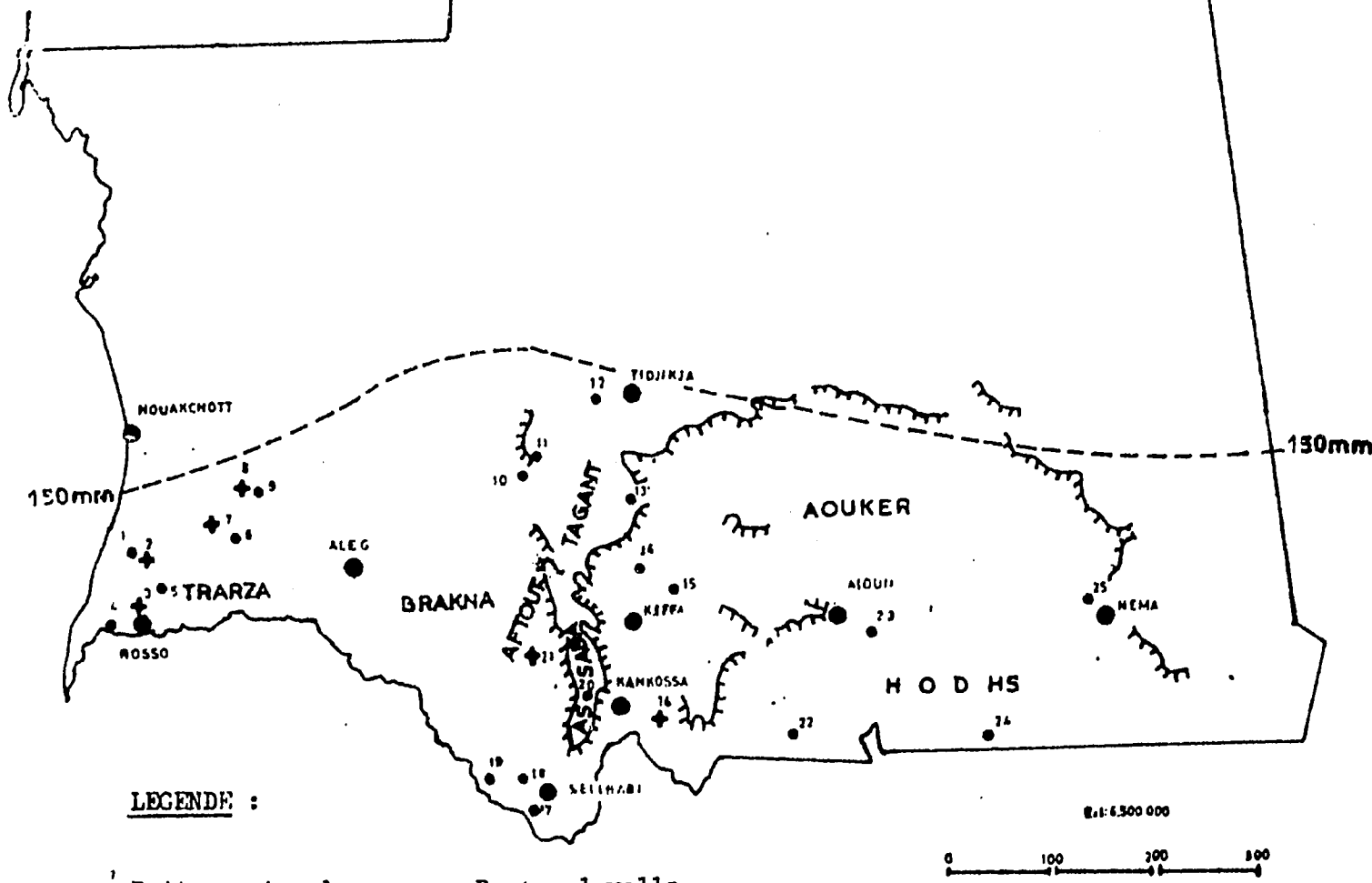
LOCALISATION DES PATURAGES VISITES - AUTOUR DES PUITS PASTORAUX ET AUTRES PARCOURS - ET REGIONS PHYSIQUES

LOCALIZATION OF VISITED GRAZING LAND - AROUND PASTORAL WELLS AND OTHER TRAILS - AND PHYSICAL REGIONS

Carte 4
Map



LEGENDE :

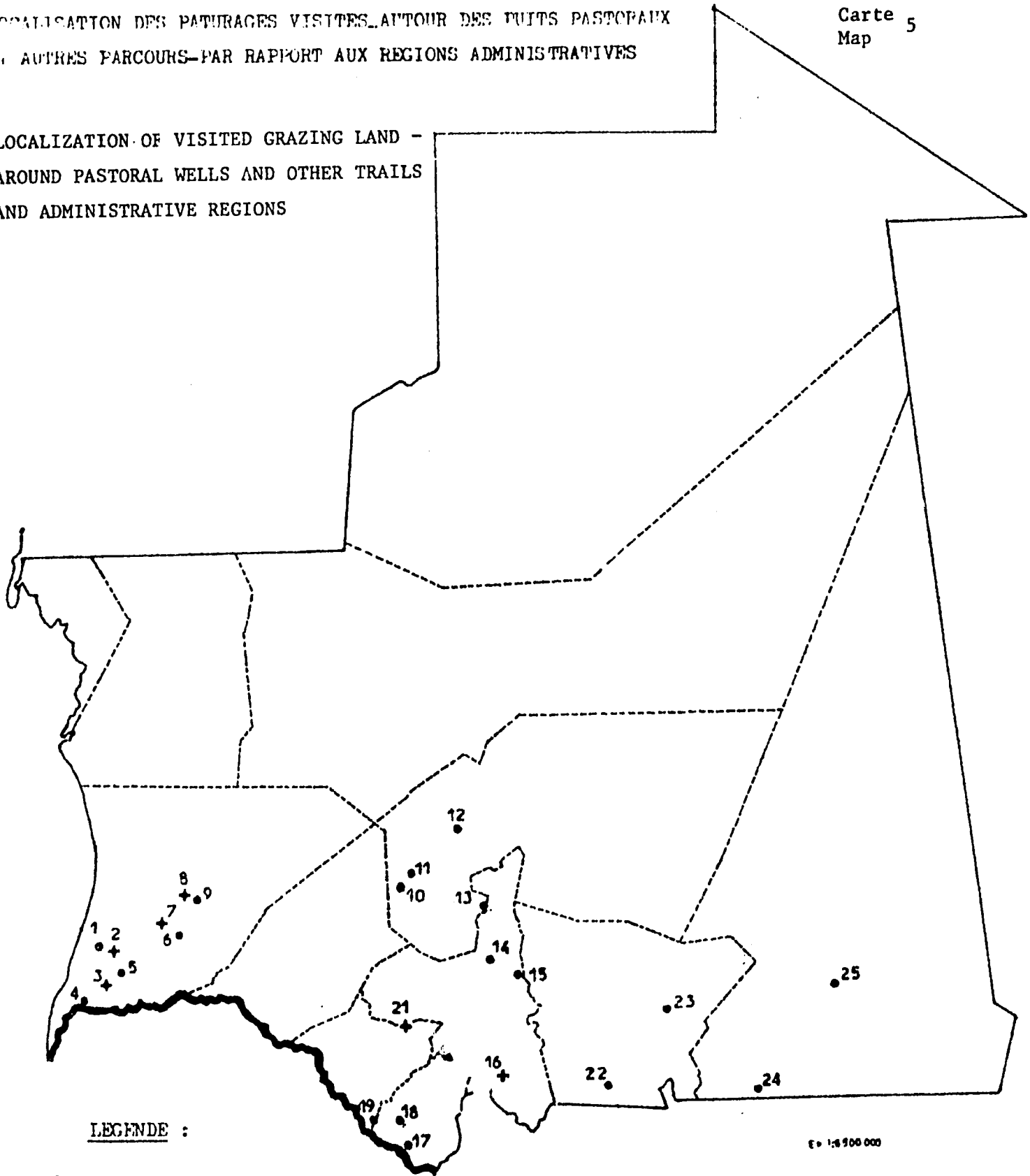
Puits pastoral	Pastoral wells	
Parcours	Trails	
Villes	Towns	
Isohyète 150 mm	Isohyet 150 mm	SOURCE : Auteur, RAMS 1980 Author, RAMS 1980
Escarpements	Escarpments	

Previous Page Blank

LOCALISATION DES PATURAGES VISITES AUTOUR DES PUITS PASTORAUX ET AUTRES PARCOURS-PAR RAPPORT AUX REGIONS ADMINISTRATIVES

Carte 5
Map

LOCALIZATION OF VISITED GRAZING LAND - AROUND PASTORAL WELLS AND OTHER TRAILS AND ADMINISTRATIVE REGIONS



LEGENDE :

2 ✚ Puits pastoral — Pastoral wells

7 • Parcours — Trails

_____ Limite administrative
Administrative limit

SOURCE : Auteur. RAMS 1980
Author, RAMS 1980

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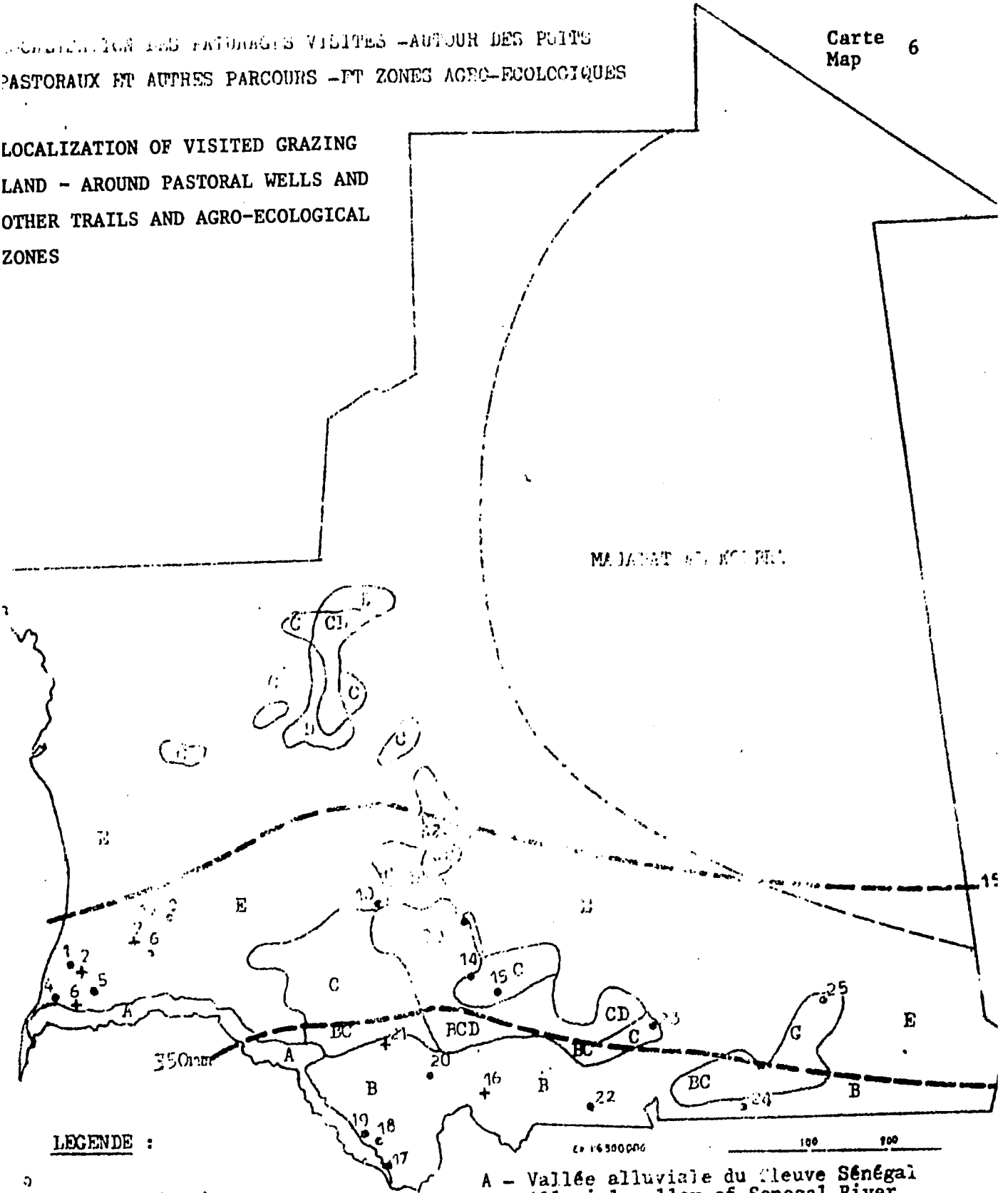
Carte 6
Map

LOCALISATION DES PATURAGES VISITES -AUTOUR DES PUITS PASTORAUX ET AUTRES PARCOURS -ET ZONES AGRO-ECOLOGIQUES

LOCALIZATION OF VISITED GRAZING LAND - AROUND PASTORAL WELLS AND OTHER TRAILS AND AGRO-ECOLOGICAL ZONES



LEGENDE :

+ Puits pastoral — Pastoral wells

Parcours — Trails

Limite de zone agro-écologique
Agro-ecological limits

Limite de la Majabat Al Koubra
Limit of the Majabat Al Koubra

Isohyètes 150 et 350 mm
Isohyets 150 and 350 mm

A - Vallée alluviale du fleuve Sénégal
Alluvial valley of Senegal River

B - Cultures sous pluies
Rainfed agriculture

C - Cultures de décrue des oueds
Recessional agriculture in wadi

D - Palmeraies
Palm groves

E - Pastorale
Pasture area

SOURCE : Auteur. RAMS 1980
Author, RAMS 1980

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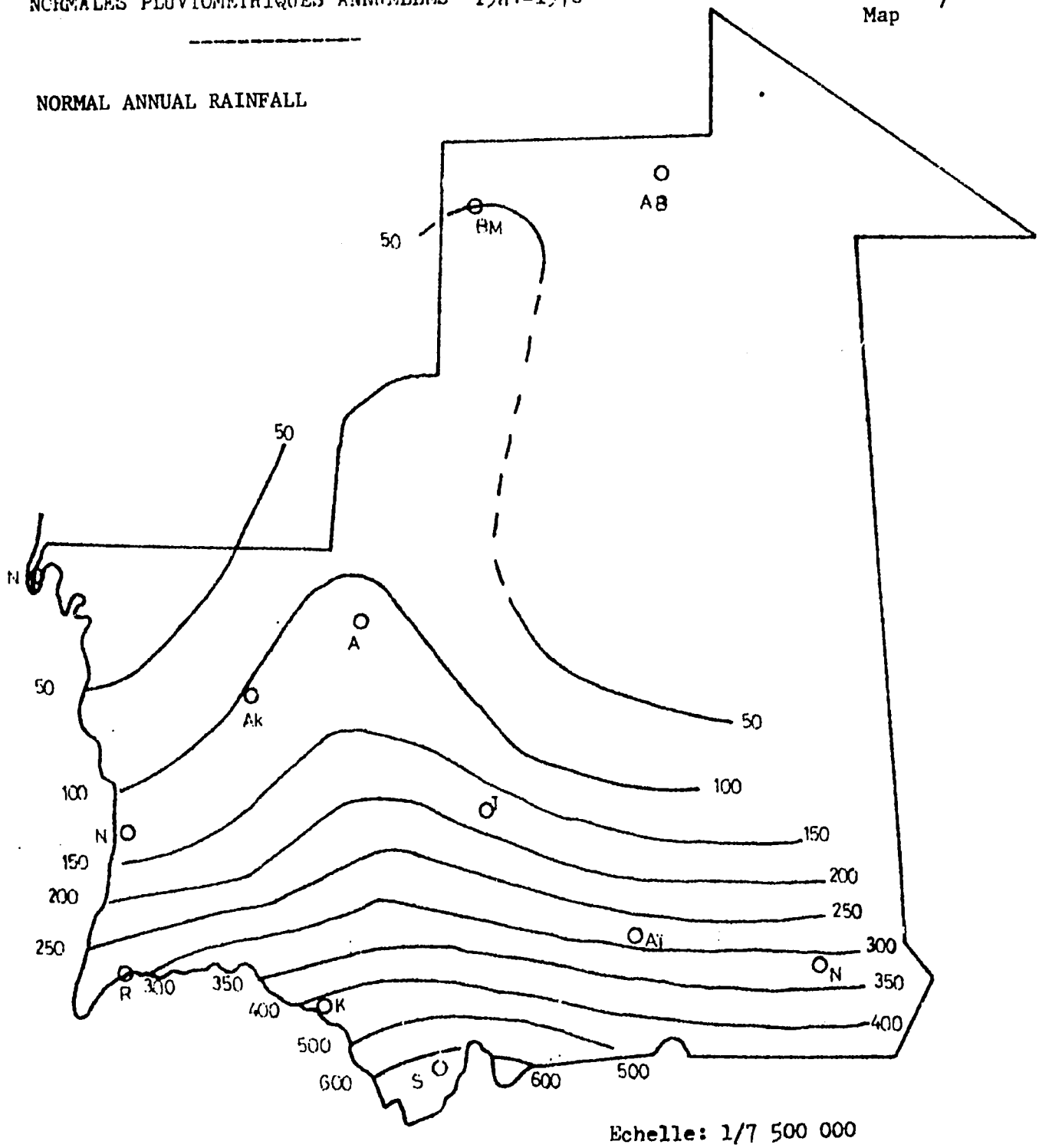
NORMALES PLUVIOMETRIQUES ANNUELLES 1941-1970

Carte 7
Map

NORMAL ANNUAL RAINFALL



Echelle: 1/7 500 000
Scale

SOURCE : PNUD/OMM/AGRHYMET.

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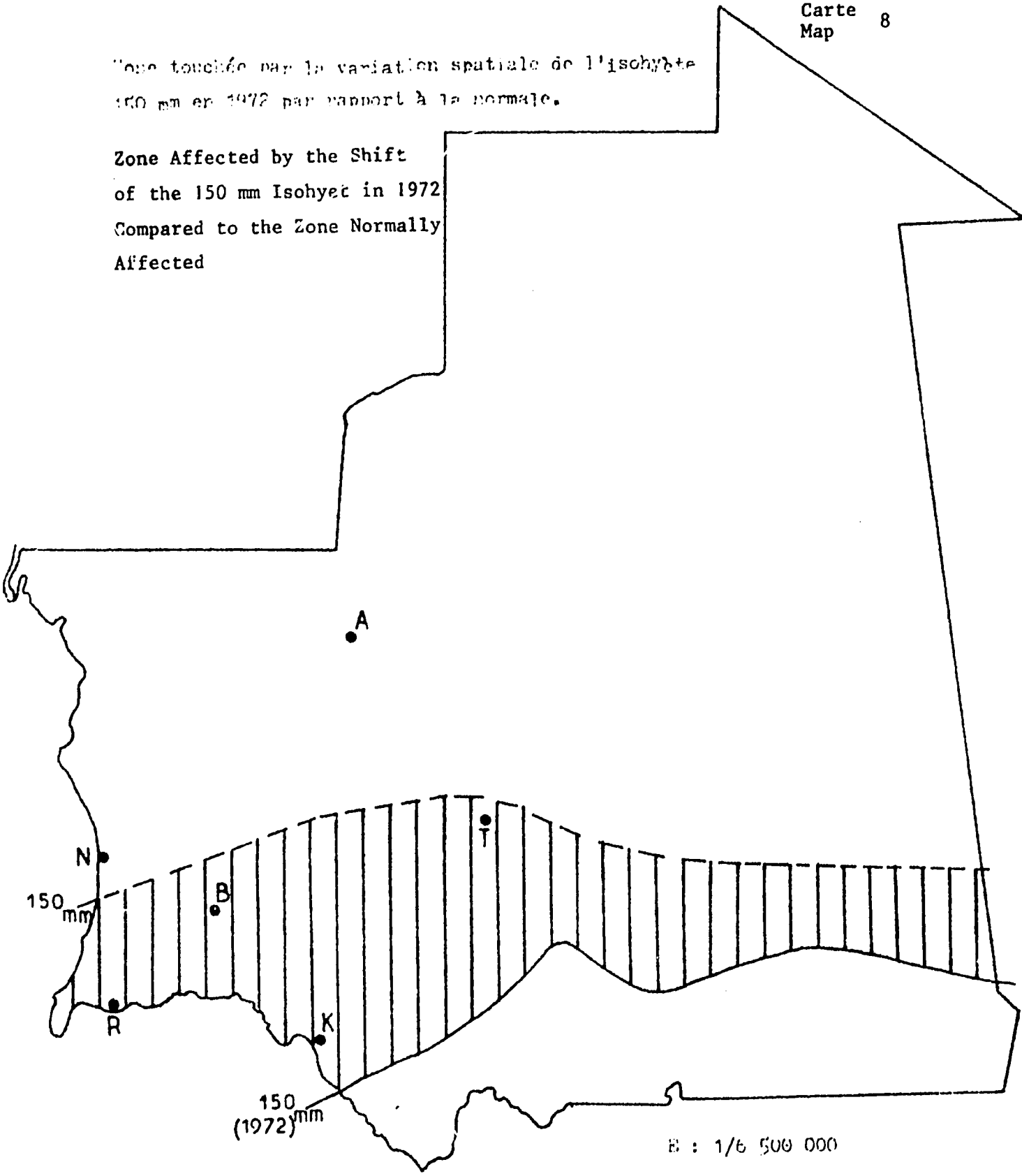
Carte 8
Map

Zone touchée par la variation spatiale de l'isohyète 150 mm en 1972 par rapport à la normale.

Zone Affected by the Shift of the 150 mm Isohyet in 1972 Compared to the Zone Normally Affected



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Les Figures 9 à 14 sont inclues dans le texte du

The Figures 9 to 14 are included in the text of the

rapport.

report.

Fig. 9	Mederdra 1954-1979	(cf. Chap. 3.4.4)	
Fig. 10	Boutilimit 1954-1979	(cf. Chap. 3.4.4)	
Fig. 11	Aleg 1954-1980	(cf. Chap. 3.4.4)	
Fig. 12	Selibabi 1952-53-1980	(cf. Chap. 3.4.4)	
Fig. 13	Répartition des gommiers Gum tree distribution	(Acacia sénégal) (Acacia senegal)	(cf.Chap.3.9.5)
Fig. 14	Répartition des gonakiers Gonakiers distribution	(Acacia nilotica) (Acacia nilotica)	(cf.Chap.3.9.6)

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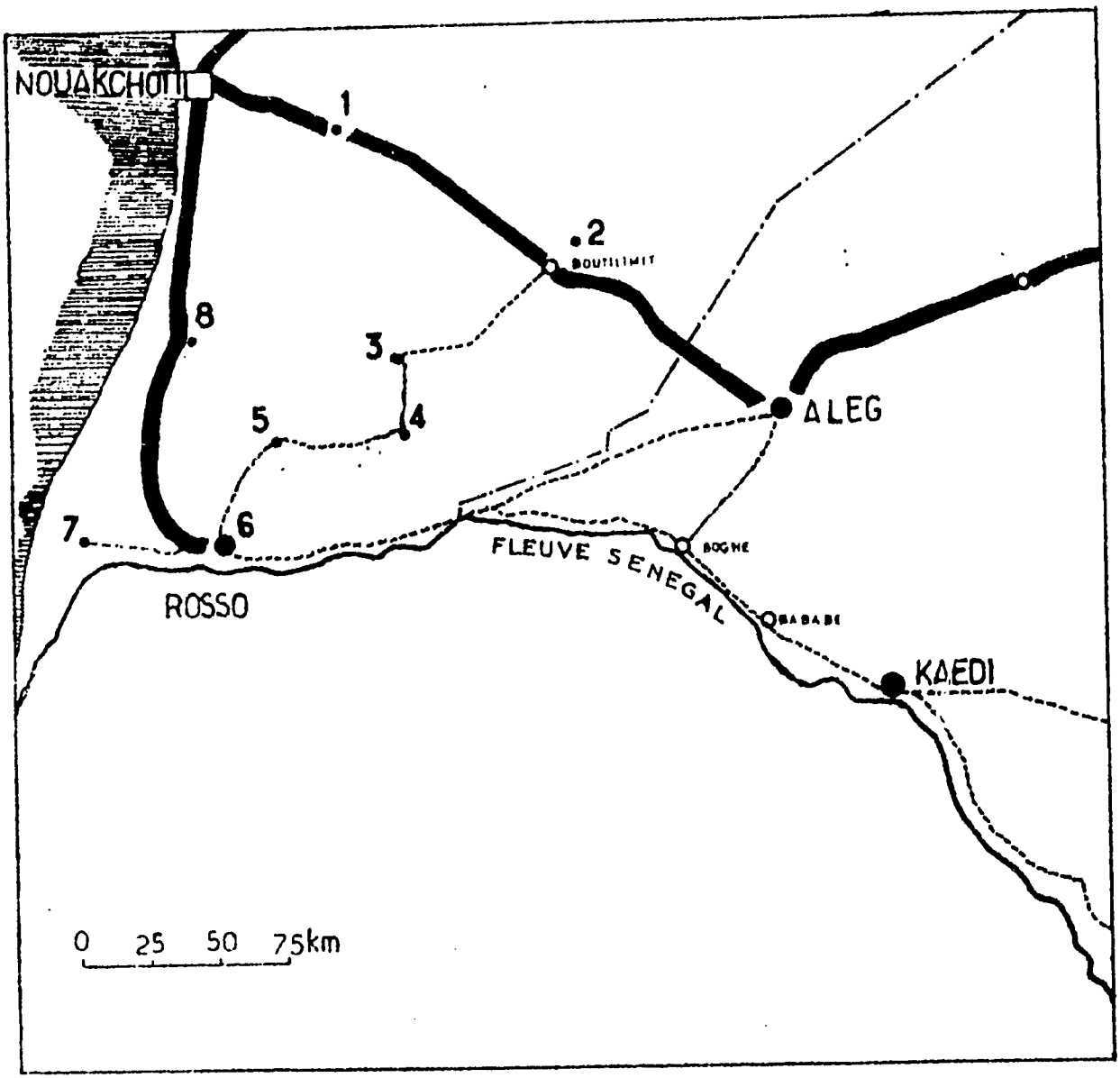
MISSION ENVIRONNEMENT-TRARZA

TRARZA ENVIRONMENT MISSION



● Chef-lieu de région Regional headquarters

○ Chef-lieu de département Departmental Head-quarters

● Localités visitées Visited Towns

Routes bitumées Paved roads

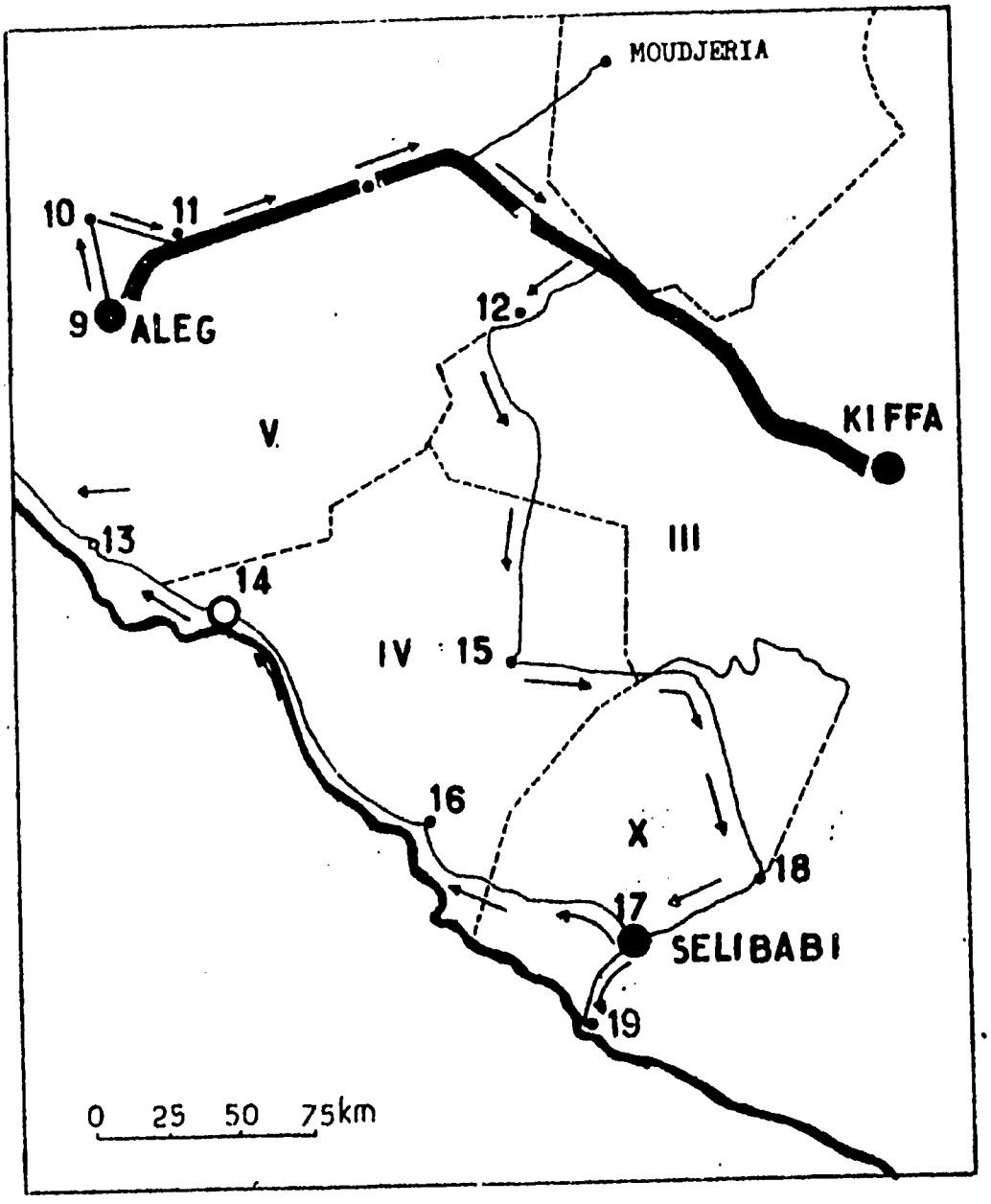
Limite administrative Administrative limit

Pistes Tracks

1 Ouad Naga
2 Aïn Salama
3 Bareïna
4 R'Kiz
5 Mederdra
6 Rosso
7 Keur Macene
8 Tiguent

MISSION ENVIRONNEMENT : BRAKNA, GORGOL, GUIDIMAKHA

ENVIRONMENT MISSION: BRAKNA, GORGOL, GUIDIMAKHA



- Villes visitées / Visited towns
- Chef-lieu de région / Regional headquarters
- Limite administrative / Administrative limit
- Pistes / Tracks
- Routes bitumée / Paved roads

9 Aleg
10 Bou Ghbeira
11 Cheggar
12 Dienaba
13 Bababé
14 Kaédi
15 M'Bout
16 Maghama
17 Sélibabi
18 Ould Yenge
19 Gouraye

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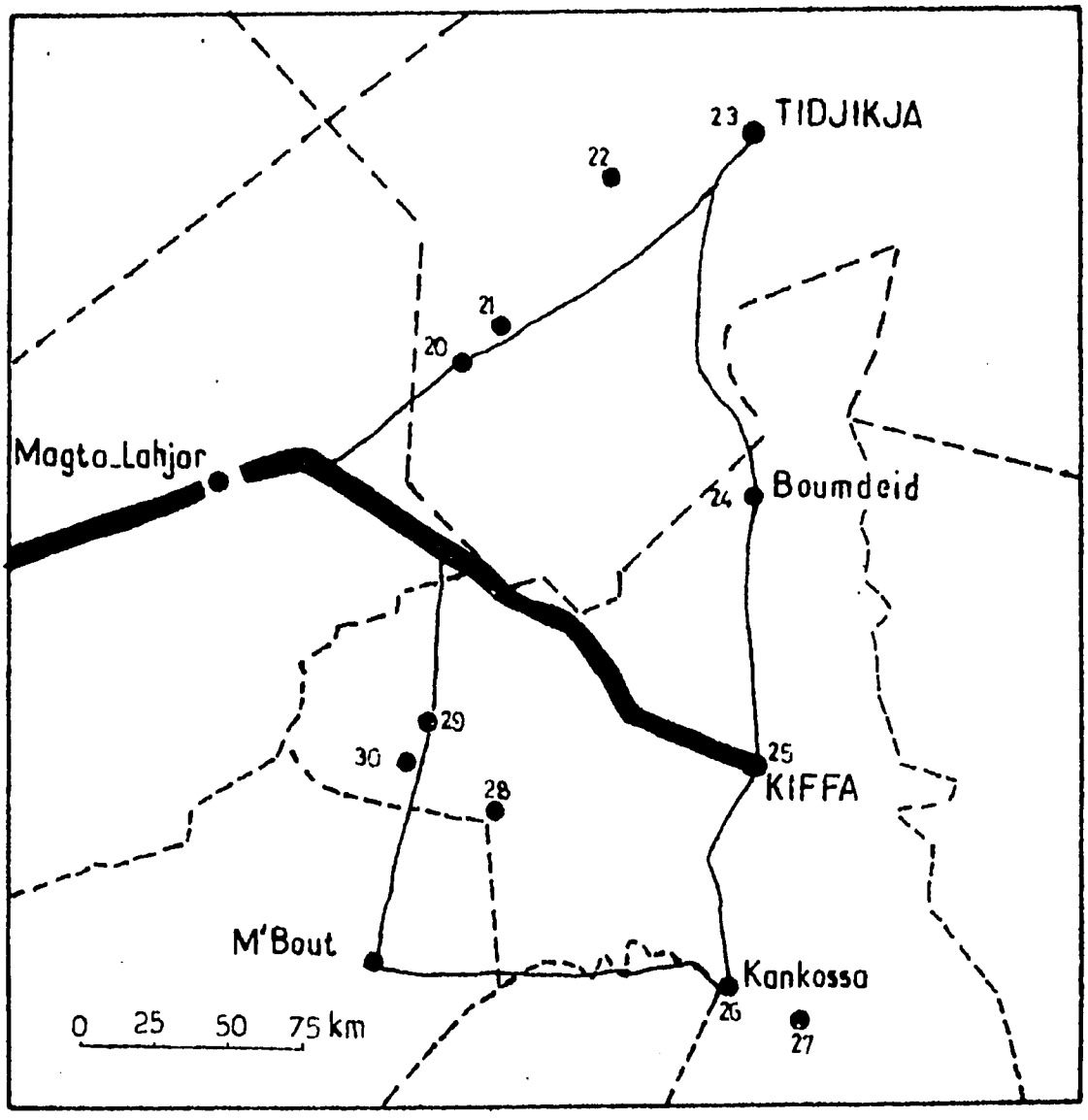
MISSION ENVIRONNEMENT TAGANT - ASSABA

ENVIRONMENT MISSION: TAGANT, ASSABA



20 Moudjéria
21 N'Beika
22 Aghlambit
23 Tidjikja
24 Boudeid
25 Kiffa
26 Kankossa
27 Aïn Teiss
28 Laouessi
29 Barkewel
30 Ghabra

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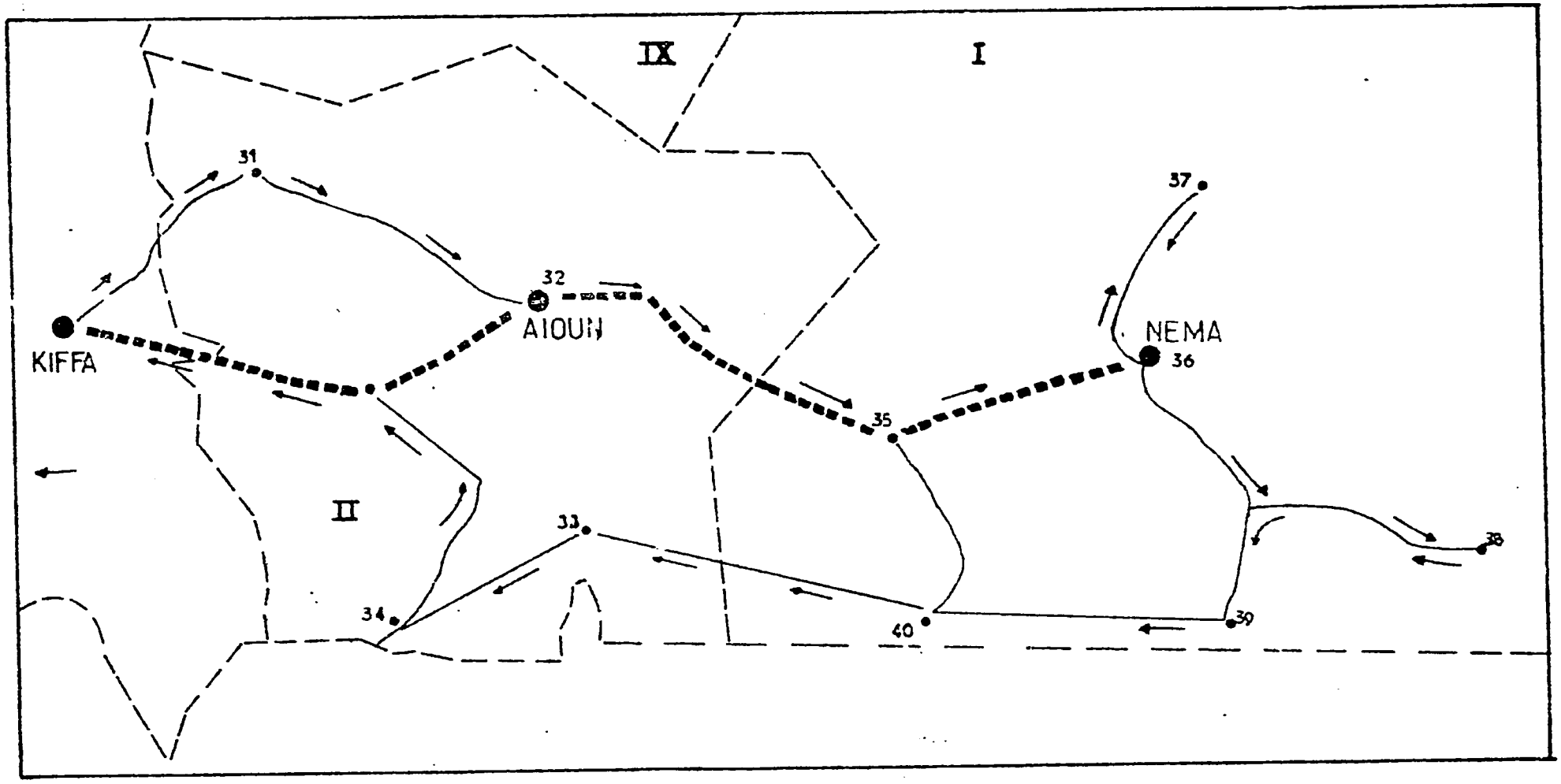
Carte 18
Map

MISSION ENVIRONNEMENT DANS LES HODHS

ENVIRONMENT MISSION IN THE HODHS



31 Tamchakett
32 Aïoun El Atrouss
33 Keboni
34 Touil
35 Timbedra
36 Néma
37 Oualata
38 Bassikounou
39 Abdel Bagrou
40 Bousteila.

0 25 50 75 km

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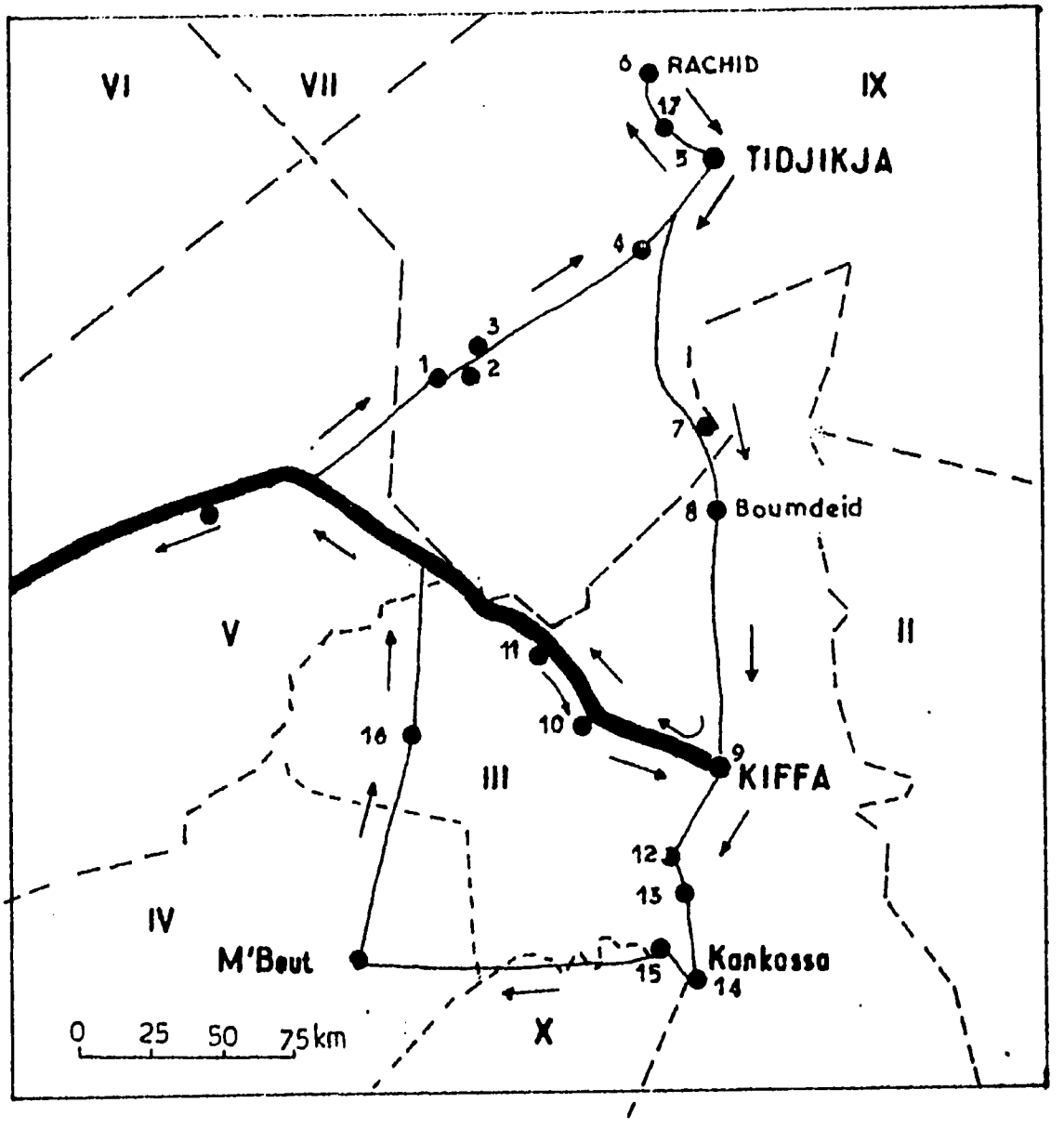
MISSION OASIS - ENVIRONNEMENT

OASIS ENVIRONMENT MISSION



1) Moudjeria
2) El Hosseinia
3) N'Beika
4) Niemelane
5) Tidjikja
6) Rachid
7) El Khedia
8) Boumdeid
9 Kiffa
10) Guerou.
11) Kamour
12) El Feye
13) Kouroudjel
14)Kankossa
15) Sani
16) Barkewol
17) Lahouetat

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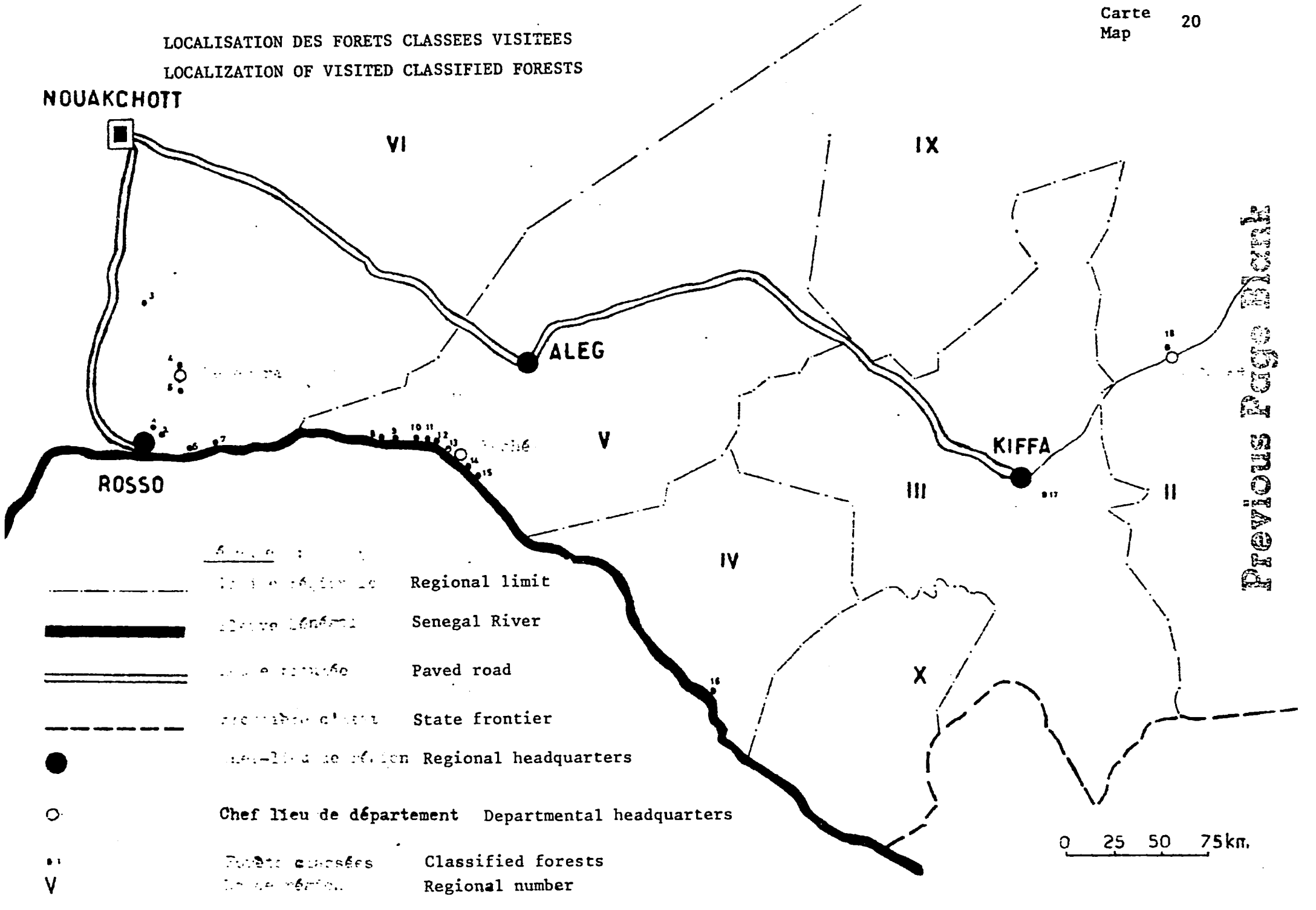
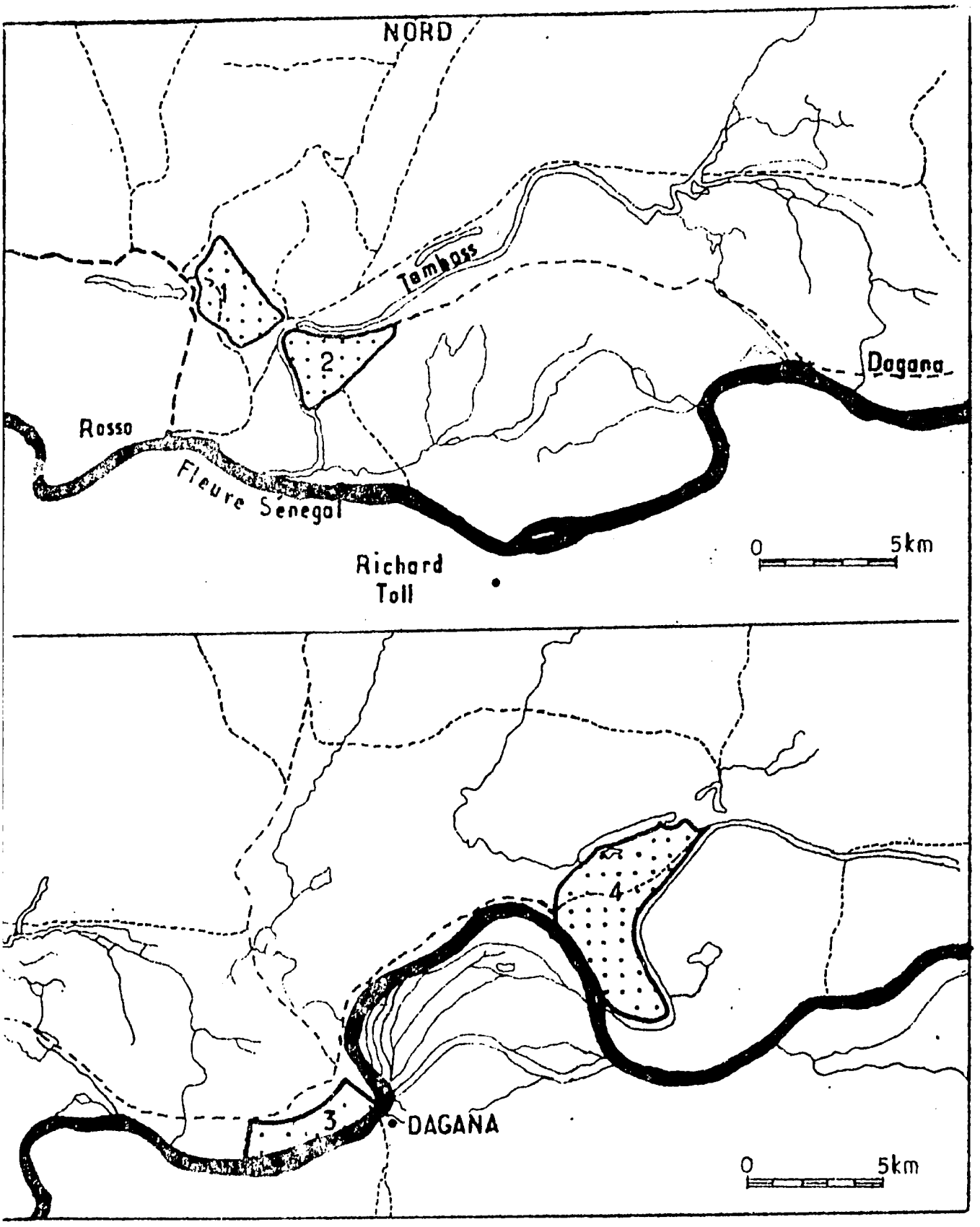
Carte 20
Map

LOCALISATION DES FORETS CLASSEES VISITEES

LOCALIZATION OF VISITED CLASSIFIED FORESTS





— Cours d'eau Stream

Mares temporaires Temporary pools

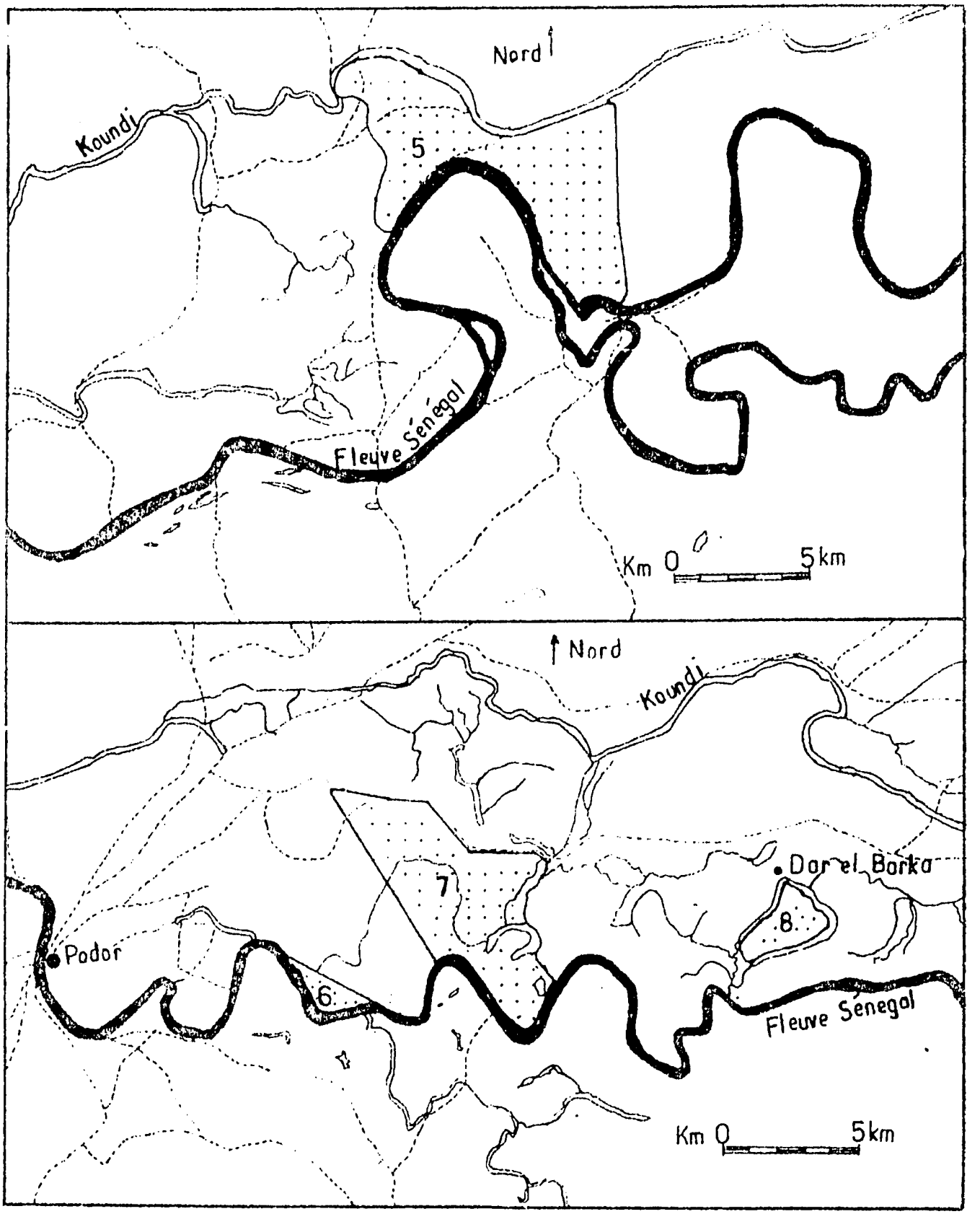
Pistes Tracks

FORETS CLASSEES: Classified Forest

1. Tine Beunar
2. Tounguen (périmètre de reboiseme
3. Dagana
4. Gani

Carte
Map 21

Université Cheikh Anta Diop de Dakar



FORETS CLASSEES Classified Forests

Cours d'eau Stream

Mares temporaires Temporary pools

Pistes Tracks

5. KOUNDI

6. TESSEM

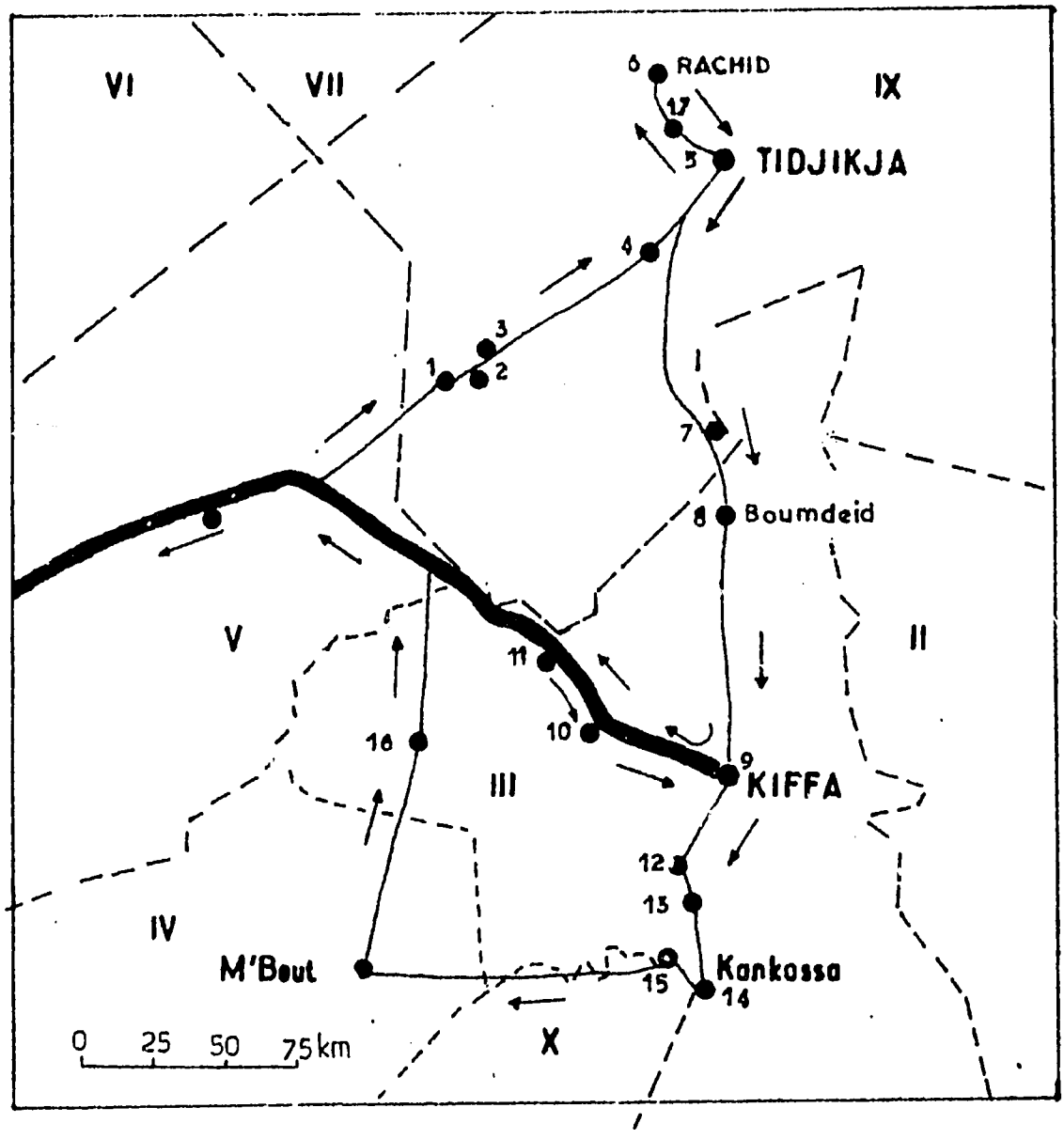
7. M'POYO

8. DAR EL BARKA

Carte
Map

MISSION OASIS - ENVIRONNEMENT

OASIS ENVIRONMENT MISSION



1) Moudjeria
2) El Hosseinia
3) N'Beika
4) Niemelane
5) Tidjikja
6) Rachid
7) El Khedia
8) Boumdeid
9 Kiffa
10) Guerou.
11) Kamour
12) El Feye
13) Kouroudjel
14)Kankossa
15) Sani
16) Barkewol
17) Lahouetat

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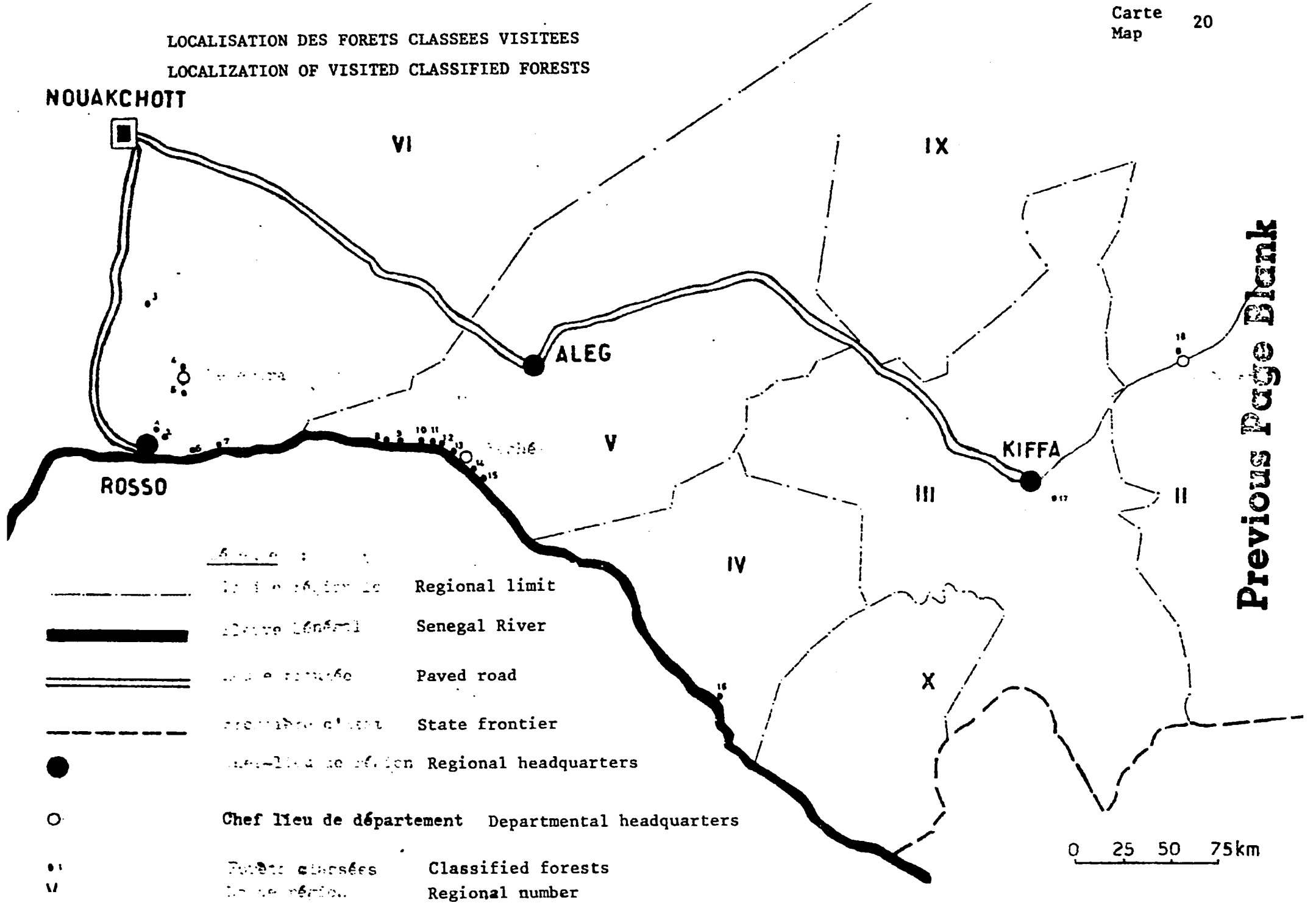
Carte 20
Map

LOCALISATION DES FORETS CLASSEES VISITEES

LOCALIZATION OF VISITED CLASSIFIED FORESTS



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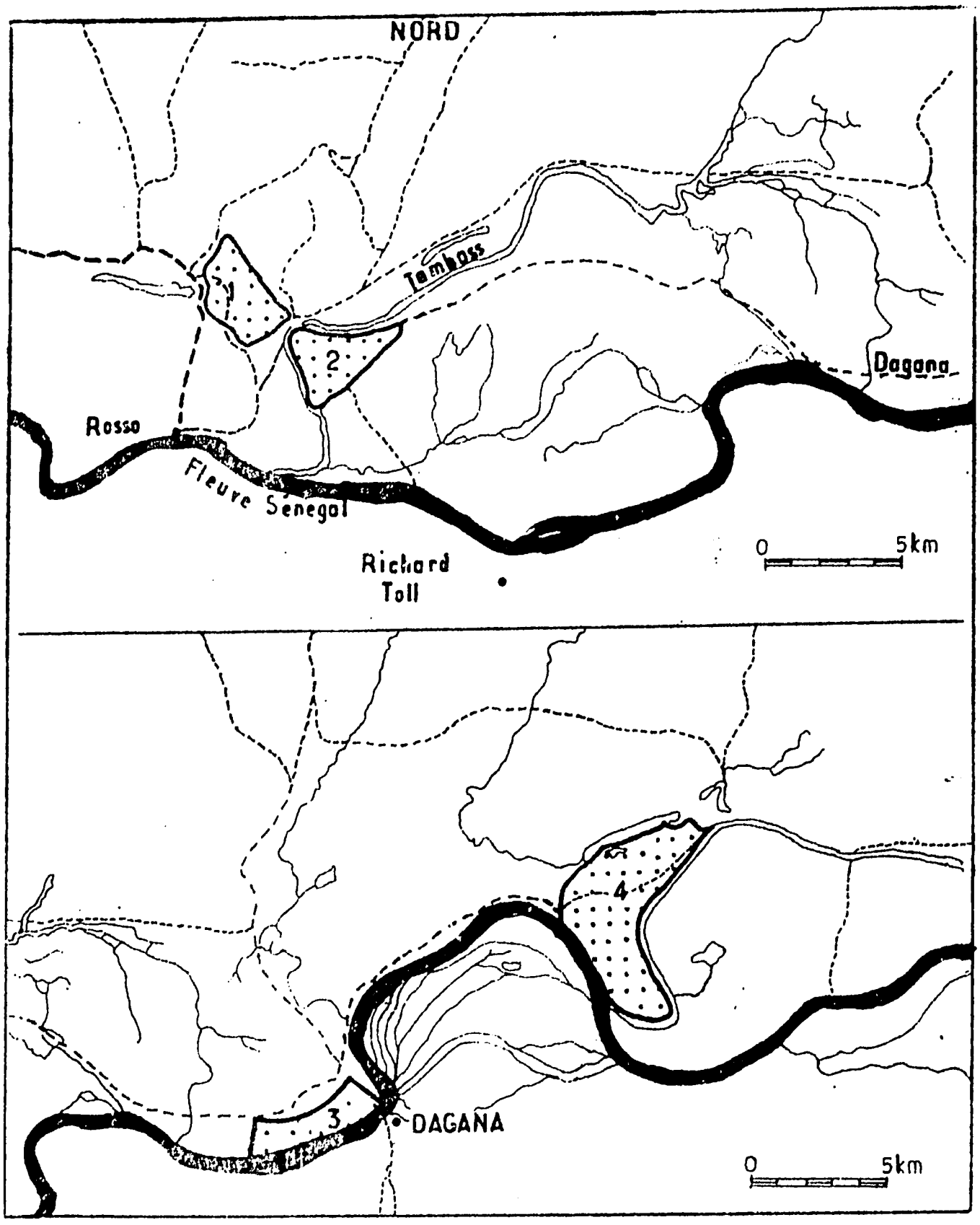

— Cours d'eau Stream

Mares temporaires Temporary pools

Pistes Tracks

FORETS CLASSEES: Classified Forests

1. Tine Beunar
2. Tounguen (périmètre de reboisement
3. Dagana
4. Gani

Carte
Map

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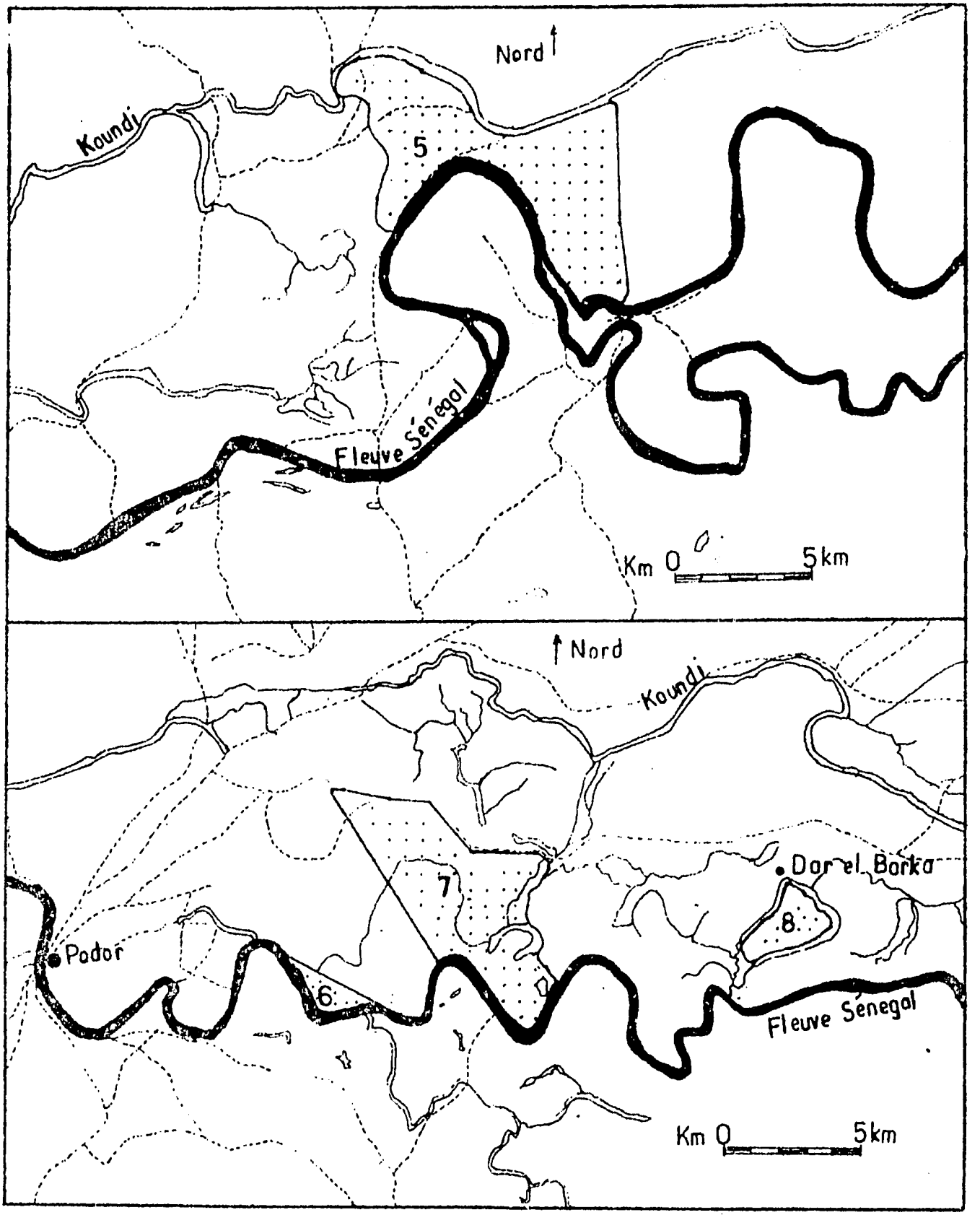

FORETS CLASSEES Classified Forests

------ Cours d'eau Stream

Mares temporaires Temporary pools

Pistes Tracks

5. KOUNDI
6. TESSEM
7. M'POYO
8. DAR EL BARKA

Carte Map 22

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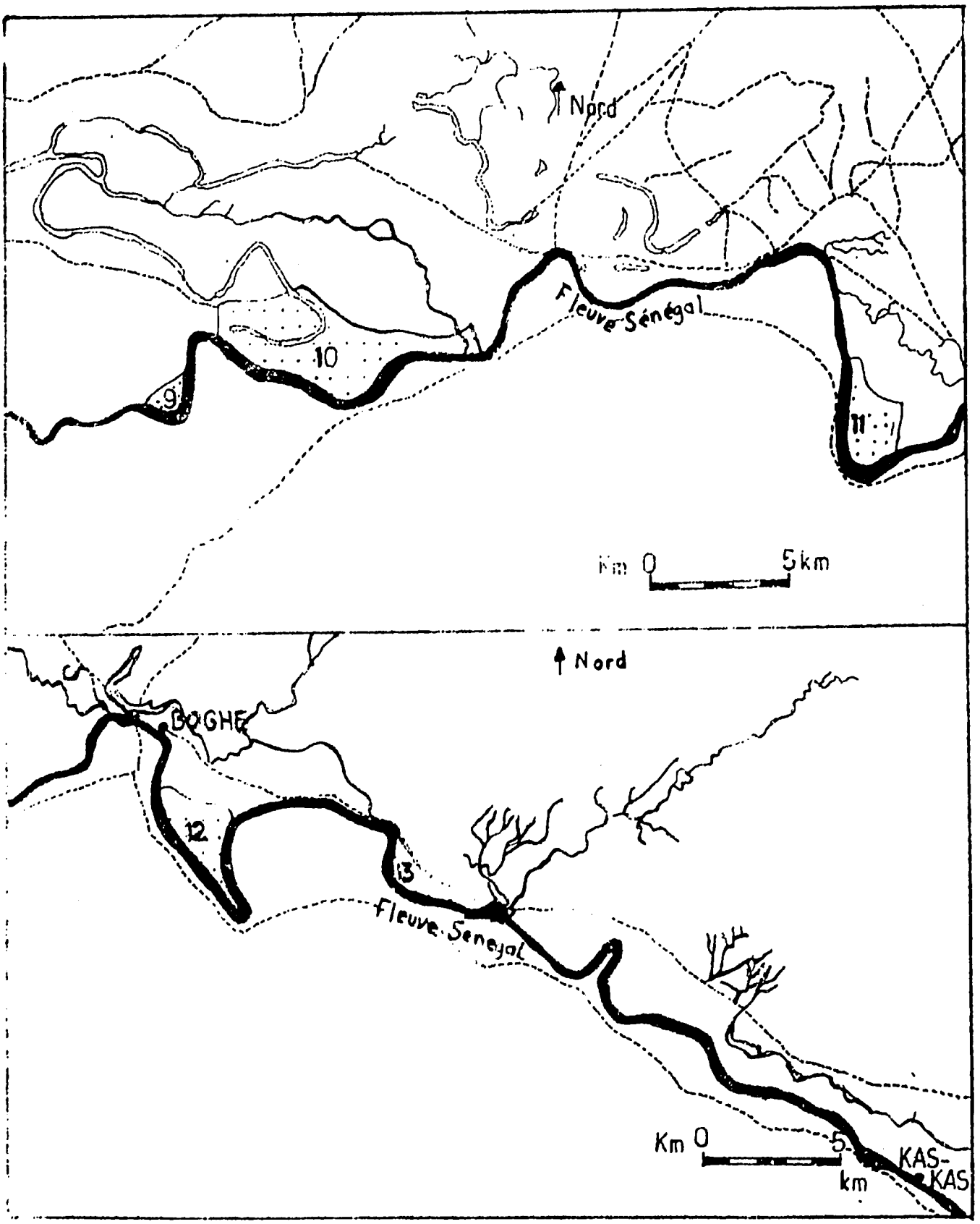

Cours d'eau	Stream	
Mares temporaires	Temporary pools	
Pistes	Tracks	

FORETS CLASSEES Classified Forests

9. OLO-OLOGO
10. SILBE
11. LOPEL
12. SANKI
13. OUALALDE

Carte 23
Map

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Annexe II

Appendix II

Fiches de Transect de Végétation

Transect of Vegetation Cards

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Observation Date: 5/15/1980 Department Ouad Naga

Region: Trarza 06

Location: Ouad Naga

Transect: South West A N° 1

Topography	Depression between dunes (goud)- flat surface		
State of soil surface	Sandy clay soil		
I Ligneous	Species	height	Proportion %
	1) Capparis decidua	1 m	80%
	2) Acacia senegal	1 m	20%
verage range	30 m		
I Herbaceous	Leptadenia spartium	Percentage of overall coverage 5%	
eneral state f grass land	-Some dead Commiphora africana -Some dead Grewia tenax -Severely degraded pasture lands -Area of degradation around the locality: average 1.000m		

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Observation Date: 5/16/1980 Department: Boutilimit

Region: Trarza 06

Location: Ain Salama

Transect: South West N° 2

Topography	Depressions between dunes (goud) - flat surface		
State of soil surface	Sandy slabs on clay substrat		
I Ligneous	Species	Height	Proportio %
	1) Acacia raddiana	0.5 to5m	40%
	2) Balanites aegyptiaca	2 to 3m	30%
	3) Maerua crassifolia	0.5 tolm	30%
	4) Capparis decidua	0.5 tolm	
Average range	5 to 20 m		
II Herbaceous	Insignificant dry mulch carpet	Percentage of overall coverage 5%	
General state of grass land	- Big Balanites and Acacia are prunned - Considerable regeneration of Acacia raddiana and Capparis decidua - More or less degraded pasture - Area of degradation around the town: average 500m		

Observation Date: 5/15/1980 Department Ouad Naga

Region: Trarza 06

Location: Ouad Naga

Transect: North East B N° 1

Topography	realm of the Trarza's dunes -- Succession of dunes(frequently remobilized) and depressions between dunes (goud)North-East-South-West oriented		
State of soil surface	More or less fixed sandy soil - Sandy clay soil in the depressions		
I Ligneous	Species	Height	Proportion
	1) Acacia raddiana	2 to 3m	50%
	2) Balanites aegyptiaca	1 to 2m	30%
	3) Capparis decidua	1,5 m	20%
	4) Maerua crassifolia	5 m	
	5) Acacia senegal	2 to 3m	
	6) Commiphora africana		
Average range	20 to 30 m		
Herbaceous	- Grammineous mulch (Akchert) - Tufts of Panicum turgidum	Percentage of overall coverage < 5%	
General state of grass land	- About 50% of Commiphora africana are dead as well as the most of gum trees - Very degraded grazing lands - Area of degradation: about 1000m average		

Observation Date: 5/16/1980 Department: R3Kiz

Region: Trarza 06

Location: Barcina

Transect: West N° 3

Topography	Depression between dunes (goud)		
State of soil surface	Fixed sandy soil		
I Ligneous	Species	Height	Proportio
	1) Balanites aegyptiaca	0.5 to 8m	50%
	2) Acacia senegal	0.5 to 3m	50%
Average range	- In the low ground of goud: 2 to 10 m - On the borders of goud : 30 m		
II Herbaceous	- Tufts of Panicum Turgidum - Leptadenia spartium 0.5o m	Percentage of overall coverage ±20%	
General state of grass land	- 40% of Acacia Senegal are dead in places - Leptadenia spartium is very grazed by animals - Cutting and prunning of Balanites aegyptiaca especially - These two species are imbricated and equal in this area - Pastures in degradation - Area of desertification: 1 to 2 km		

Observation Date: 5/17/1980 Department R'Kiz

Region: Trarza 06

Location: R'Kiz

Transect: East A N° 4

Topography	Plain - Bank of lake		
State of soil surface	Clay to sandy clay soils		
I Ligneous	Species	Height	Proportion%
	1) Acacia raddiana	0.5 to 8m	50%
	2) Capparis decidua	2 to 4m	10%
	3) Acacia flava	1.5 to 2m	10%
	4) Acacia senegal	1.5 to 2m	10%
	5) Balanites aegyptiaca	1.5 to 8m	:
	6) Acacia nilotica	3m	: 30%
	7) Bauhinia rufescens	2m	:
	8) Zizyphus mauritiana	2m	:
verage range	2 to 15 m		
erbaceous	none	Percentage of overall coverage	
eneral state f grass land	- Young trees are grazed, the big ones are cut and prunned - Pasture lands on way to degradation - Area of degradation in a radius of 500 to 1000 m, pronounced by Calothropis procera		

Observation Date: 5/17/1980 Department R'Kiz

Region: Trarza 06

Location: R'Kiz

Transect: North B N° 4

Topography	Flat ground		
State of soil surface	Clay and grey brown soil in places		
I Ligneous	Species	Height	Proportion
	1) Balanites aegyptiaca	0.5 to 5m	50%
	2) Acacia raddiana	0.5 to 10m	20%
	3) Acacia senegal	1 to 3m:	
	4) Capparis decidua	0.5 to 2m:	30%
	5) Zizyphus mauritiana	0.5 to 1m:	
	6) Acacia flava	1.5m :	
Average range	1 to 50 m		
II Herbaceous	very small traces of graminieous	Percentage of overall coverage	
General state of grass land	- Trees are truncated - Pasture land in good state - Area of degradation about 1000 to 1500 m in which subsist only some old Acacia raddiana		

Observation Date: 5/23/1980 Department Mederdra

Region: Trarza 06

Location: Mederdra

Transect: South West N° 5

Topography	Alignements of leveled dunes alternating with depressions (goud)		
State of soil surface	Sandy soil relatively fixed on the dunes Sandy clay in the gouds		
I Ligneous	Species	Height	Proportion
	1) Acacia senegal	0.5 to 5m	40%
	2) Balanites aegyptiaca	0.5 to 8m	40%
	3) Acacia raddiana	0.5 to 4m	20%
verage range	3 to 10 m and over		
II Herbaceous	Cenchrus biflorus mulch	Percentage of overall coverage < 5%	
General state of grass land	- 30 to 50% of gum trees are dead - Desert area with old dunes as well as new dunes taking shape (See OMVS photographer 08-02-1980 of Mederdra) - Severely degraded pasture land. Anciently cultivated fields with clearings - Area of new dune movement to East and West of town along dune alignement		

Observation Date: 5/30/1980 Department Rosso

Region: Trarza 06

Location Rosso

Transect: North East N° 6

Topography	Ar a in the alluvial plain of the Senegal River		
State of soil surface	Sandy clay loam soil with indurated areas		
I Ligneous	Species	Height	Proporti %
	1) Tamarix aphylla	0.5 to 1.8m	80%
	2) Balanites aegyptiaca	0.5 to 5m	:
	3) Acacia albida	0.5m	: 20%
	4) Acacia seyal	0.5 to 2m	:
	5) Prosopis sp	8m	:
Average range	5 to 15 m		
II Herbaceous	bush of 10 to 30 cm, height indertermined in places	Percentage of overall coverage ± 50 %	
General state of grass land	- Fairly mediocre - Comprised and stamped down soil - Insignificant pasture land - Generalized and dispersed degradation		

Observation Date: 5/30/ 1980 Department Keur Macene

Region: Trarza 06

Location: Keur Macene

Transect: North N° 7

Topography	Succession of dunes and clayey low grouhds along the walo of Senegal River		
State of soil surface	Sandy soil on dunes and sandy clay in depressions (gouds) and completely clayey in the walo		
I Ligneous	Species	Height	Proportion
	1) Acacia albida	0.5 to 4m	30%
	2) Euphorbia balsamifera	1 to 1.5m	20%
	3) Balanites aegyptiaca	0.5 to 1m:	
	4) Acacia nilotica	0.5 to 5m:	
	5) Salvadora persica	3m :	50%
	6) Tamarix aphylla	0.5 to 1m:	
Average range	5 to 10 m		
II Herbaceous	- many tufts of various mulch o.20 to 0.50 - rare tufts of panicum turgidum	Percentage of overall coverage > 20%	
General state of grass land	- Considerable regenoration of Acacia albida and nilotica in the clayey depression - The dominance of Euphorbia in the dunes - In spite of the human and animal pressure , this pasture is in good state - There is no visible area of degradation		

Observation Date: 5/22/1980 Department Mederdra

Region: Trarza 06

Location: Tiguent

Transect: East N° 8

Topography	Sandy dunes of weak amplitude		
State of soil surface	Sand		
I Ligneous	Species	Height	Proportion
	) Acacia raddiana	0.5 to 2.5m	60%
	2) Acacia senegal	0.5 to 1.5m :	
	3) Balanites aegyptiaca	0.5m :	40%
	4) Maerua crassifolia	1m :	
Average range	Over 30 m and 1 to 10 m in places		
II Herbaceous	some mulch of Cenchrus bifloris	Percentage of overall coverage	< 5%
General state of grass land	- Rare cutting and pruning - Pasture land with Acacia raddiana dominant, very poor in other species - Area of degradation pronounced on about 600m of width with sharp sand		

Observation Date: 6/11/1980 Department Aleg

Region: Brakna 05

Location: Aleg

Transect: North N° 9

Topography	Flat relief and weakly furrowed Aftout ground		
State of soil surface	Sandy clay (Aftout rag type) - sandy slabs ferrugineous gravel		
I Ligneous	Species	Height	Proportion
	1) Boscia senegalensis	0.5 to 2m	80%
	2) Capparis decidua	0.5 to 3m :	20%
	3) Balanites aegyptiaca	3m :	
Average range	2 to 15m		
I Herbaceous	none	Percentage of overall coverage %	
General state of grass land	- Cutting of Balanites aegyptiaca - There is no pronounced anthropic destruction - Mediocre pasture - Area of degradation: 200 to 1000m		

Observation Date: 6/11/1980 Département Aleg

Region: Brakna 05

Location: Bou Ghbeira

Transect: North East N° 10

Topography	Brakna's dunes ; dunes alignements alternating with depressions with flat bottom (gouds)	
State of soil surface	Sand	
I Ligneous	Species	Height Proporti
	1) Balanites aegyptiaca	0.5 to 4m 60%
	2) Acacia senegal	1.5 to 2.5m ;
	3) Boscia senegalensis	0.5 to 2m ;
	4) Acacia raddiana	0.5 to 1.5m ; 40%
	5) Maerua crassifolia	0.5 to 2m ;
	6) Capparis decidua	1.5m ;
Average range	2 to 3 m	
II Herbaceous	some tufts of grammineous (mulch) on the soil Percentage of overall coverage <5%	
General state of grass land	- Very poor tree pasture - Numerous waste and bare areas without trees - There is no traces of recent cutting - Desert-like area in the goud till 1.5 km towards North	

Observation Date: 12/6/1980 Deprtment Aleg

Region: Brakna 06

Location: Choggar

Transect: West N° 11

Topography	Flat relief along the Aftout (area of contact Aftout Brakna dunes)	
State of soil surface	Sandy slabs on ferrugineous gravels and sandy clay soils of low grounds - Alignements of dunes in North	
I Ligneous	Species	Height / Proportion %
	1) Boscia senegalensis	0.5 to 2.5m 60%
	2) Acacia flava	1.5 to 3m
	3) Maerua crassifolia	0.5 to 2m
	4) Capparis decidua	1 to 1.5m
	5) Balanites aegyptiaca	0.5 to 4m
	6) Commiphora africana	1 to 2.5m
	7) Adansonia digitata	4m
erage range	2 to 15m	
Herbaceous	none Pecentage of overall coverage	
eneral state f grass land	50% Of Acacia flava are dead, the trees are in bad state and capparis decidua and balanites aegyptiaca very truncated - Aerial pasture is scarcely non existant - Area of intensive degradation toward North along 1000m - Severe deforestation	

Observation Date: 06/13/1980 Department Dionaba

Region: Brakna 05

Location: Dionaba

Transect: North A N° 12

Topography	Large dune overhanging a dam (North- East) in Aftout Various hills surrounding	
State of soil surface	Sandy soil on dunes and gravels (quartz and schist) in Aftout and on the piedmonts of hills	
I Ligneous	Species	Height Proportion
	1) Balanites aegyptiaca	1 to 4m 100%
Average range	4 to 50 m	
II Hebaceous	None Percentage of overall coverage	
General state of grass land	- Small Balanites aegyptiaca monospecific; the big ones is severely truncated - Anthropic action is very pronounced Area of degradation: about 500m arround the location	

Observation Date: 6/13/1980 Department: Dionaba

Region: Brakna 05

Location: Dioanaba

Transect: North B N° 12

Topography	Flat relief with characteristic Aftout gullies	
State of soil surface	Sandy clay (yelowish colour) with gravels	
I Ligneous	Species	Height Proportio
	1) Balanites aegyptiaca	0.5 to 3m 50%
	2) Acacia seyal	0.5 to 2m 10%
	3) Capparis decidua	0.5 to 1.5m :
	4) Zizyphus mauritiana	1 to 3m : 40%
	5) Acacia flava	1 to 3m :
	6) Acacia nilotica	4 to 6m
verage range	1 to 10 m	
I Herbaceous	none Percentage of overall coverage	
eneral state f grass land	- Monospecific Balanites aegyptiaca; Aerial pasture fairly important along the gullies. During the rain season there is a following vegetation: - Brahiaria (azz in Moor) - Barakala (in Moor) - Indigofera sency - Alysicarpus ovalifolius ("Sankali" in Moor) - Cenchrus biflorus - Area of degradation: 500 m arround the location	

Observation Date: 06/21/1980 Department Bababe

Region: Brakna 06

Location: Bababe

Transect: West N° 13

Topography	Flat area along the walo of Senegal River	
State of soil surface	Areas of gravels alternating with sandy areas	
I Ligneous	Species	Height Proportion
	1) Boscia senegalensis 2) Balanites aegyptiaca 3) Capparis decidua	0.5 to 1m 80% 0.5 to 2m : 20% 1 to 2m :
Average range	5 to 20 m	
II Herbaceous	None Pecentage of overall coverage	
General state of grass land	-Very poor pasture - Areas of degradation; about 500m	

Observation Date: 06/20/1980 Department Kaedi

Region: Gorgol 04

Location: Kaedi

Transect: North East A N° 14

Topography	Flushing rocks . A little hilly relief		
State of soil surface	Sandy soil with a few gravels		
I Ligneous	Species	Height	Proportion
	1) Acacia raddiana	0.5 to 7m	60%
	2) Balanites aegyptiaca	1 to 4m	20%
	3) Acacia flava	0.5 to 1.5m :	
	4) Bauhinia rufescens	0.5 to 1.5m :	20%
	5) Zizyphus mauritiana	1 to 3m :	
	6) Adansonia digitata	5m :	
Average range	5 to 20 m		
II Herbaceous	a few herbaceous vegetation	Percentage of overall coverage	< 5%
General state of grass land	-- A little degraded pasture -- Diffuse degradation		

Observation Date: 06/21/1980 Department Kaedi

Region: Gorgol 04

Location: Kaedi

Transect; West B N° 14

Topography	Flat area with hills at North West	
State of soil surface	Sandy clay soil, small ferrugineous gravels	
I Ligneous	Species	Height Proportic
	1) Balanites aegyptiaca	0.5 to 3m 50%
	2) Boscia senegalensis	0,5 to 1.5m 50%
Average range	2 to 10m	
II Herbaceous	None Percentage of overall coverage	
General state of grass land	- Fairly poor pasture - Traces of vegetation cutting - Diffuse degradation	

Observation Date: 06/14/1980 Department M'Bout

Region: Gorgol 04

Location; M'Bout

Transect: South A N° 15

Topography	Plain slightly undulating broken with a lot of gullies		
State of soil surface	soil with gravels and sandy clay		
I Ligneous	Species	Height	Proportio
	1) Balanites aegyptiaca	0.5 to 3m	80%
	2) Calothropis procera	1 to 1.5m :	20%
	3) Indigofera sp	1 to 1.5m :	
Average range	2 to 30 m		
I Herbaceous	none	Percentage of overall coverage	
General state of grass land	- No pastures - Balanites aegyptiaca disseminated and truncated - Area of degradation about 1000 m with Calothropis procera		

Observation Date: 06/14/1980 Department M'Bout

Region; Gorgol 04

Location: M'Bout

Transect: East B N° 15

Topography	Plain slightly undulating broken with numerous gullies	
State of soil surface	Soil with gravels and flush with the ground of flagstone and sandstone	
I Ligneous	Species	Height Proportion
	1) Acacia flava	0.5 to 2m 60%
	2) Balanites aegyptiaca	0.5 to 2m 40%
Average range	2 to 50 m	
II herbaceous	None	Percentage of overall coverage
General state of grass land	- No pastures; a lot of bare beaches - Area of degradation (nearly bare soil) about 1000 m	

Observation Date: 06/19/ 1980 Department Maghama

Region: Gorgol 04

Location: Maghama

Transect: North N° 16

Topography	Plain along the Senegal River		
State of soil surface	Sandy to sandy clay soil		
[Ligneous	Species	Height	Proportion
	1) Combretum glutinosum	1 to 3m	80%
	2) Balanites aegyptiaca	0.5 tO 3m :	20%
	3) Acacia Senegal	0.5 to 3m :	
Average range	2 to 10 m		
: Herbaceous	None	Percentage of overall coverage	
General state of grass land	- No pasture for cattle because Combretum glutinosum is not consummed by animals - A lot of fields - Reclaiming - Degradation due to crops		

Observation Date: 06/19/1980 Department Selibabi

Region: Guidimakha

Location: Selibabi

Transect: South A N° 17

Topography	Plain surrounded with numerous hills		
State of soil surface	Sandy clayey to clay sandy Small area of ferrugineous gravels		
I Ligneous	Species	Height	Proportion
	1) Balanites aegyptiaca	0.5 to 5m	60%
	2) Acacia senegal	0.5 to 5m	20%
	3) Bauhinia rufescens	1 to 4m	:
	4) Adansonia digitata	5m	: 20%
	5) Combretum glutinosum	1 to 4m	:
verage range	10 to 50 m		
I Herbaceous	a little of mulch in low grounds	Percentage of overall coverage < 5%	
General state of grass land	- Major part of pastures is constitued of Balanites aegyptiaca shots - Area of gegradation about 1000m		

servation Date: 06/16/1980 Department Ould Yenge

gion: Guidimakha

cation; Ould Yenge

ansect: North a N° 18

pography	Flat dunes relief - Karakoro border - A lot of creeks		
ate of il surface	Sandy on dunes - clayey in low grounds		
Ligneous	Species	Height	Proportion
	1) Acacia senegal	0.5 to 4m	60%
	2) Hyphaene thebaica	6m	20%
	3) Balanites aegyptiaca	0.5 to 4m	:
	4) Combretum glutinosum	3m	: 20%
	5) Adansonia digitata	5m	:
rage range	1 to 20 m		
Herbaceous	A little of mulch of Cassia tora ("Sarsar" in Moor)	Percentage of overall coverage	5%
ieral state	- Good aerial pasture land		
grass land	- Gum trees on way to regeneration		
	- Balanites aegyptiaca and gum trees are pruned for cattle		
	- No visible area of degradation		

Observation Date: 06/19/1980 Department Selibabi

Region: Guidimakha 10

Location: Selibabi

Transect; North B N° 17

Topography	Slightly dissected plain		
State of soil surface	Ferrugineous gravels - quartz - Compressed soil (clayey with sandy slabs		
I Ligneous	Species	Height	Proporti
	1) Balanites aegyptiaca	0.5 to 5m	40%
	2) Acacia senegal	0.5 to 3m	10%
	3) Boscia senegalensis	1 to 3m	10%
	4) Zizyphus mauritiana	0.5 to 2m	:
	5) Bauhinia reticulata	1 to 4m	: 40%
	6) Adansonia digitata	5m	:
Average range	10 to 30 m		
II Herbaceous	None	Pecentage of overall coverage	
General state of grass land	- No pasture for cattle - Area of degradation about 1000 m		

servation Date: 06/18/1980 Department Salibabi

gion: Guidimakha

cation: Gouraye

ansect: South N° 19

pography	Fairly hilly relief - sandy piedmonts
ate of il surface	Outcrop of rock (quartz and schist) Clayey soils in low grounds

gneous	Species	Height	Proportion
	1) Combretum glutinosum	0.5 to 5m	60%
	2) Bauhinia reticulata	1 to 4m	20%
	3) Acacia seyal	0.5 to 8m :	
	4) Balanites aegyptiaca	2 to 4m :	
	5) Acacia nilotica	5m :	20%
	6) Bauhinia rufescens	2 to 4m :	

erage range	4 to 30 m
erbaceous	Some mulch(andropogon) Percentage of overall coverage : 5%
eral state grass land	- Good aerial pasture - Pruning for cattle (Acacia seyal)

Observation Date: 06/16/1980 Department Ould Yenge

Region: Guidimakha 10

Location: Ould Yenge

Transect: South B N° 18

Topography	Slightly undulating plain		
State of soil surface	Slabs of sandstone pebbles and sandy overlappings		
I Ligneous	Species	Height	Proport:
	1) Acacia senegal	0.5 to 4m	50%
	2) Balanites aegyptiaca	0.5 to 3m	20%
	3) Hyphaene thebaica	0.5 to 3m	20%
	4) Combretum glutinosum	2 to 5 m	:
	5) Adansonia digitata	4m	: 10%
	6) Sterculia setigera	4 to 6m	:
Average range	1 to 20 m		
II Herbaceous	None	Percentage of overall coverage	
General state of grass land	- Very poor pasture land - Balanites aegyptiaca are cut nearly at the soil level (stumps with shots) - Area of degradation about 1,000m		

Observation Date: 06/12/1980 Department Moudjeria

Region: Moudjeria

Location: Moudjeria

Transect: North West A N° 20

Topography	West piedmont of Tagant plain surrounded by an alignement of dunes (West of the town)		
State of soil surface	Alternation of clay, slabs and sandstone blocks and clayey substrat covered by sandy slabs and surrounded by moving dunes		
Ligneous	Species	Height	Proportion
	1) Acacia raddiana	0.5 to 6m	70%
	2) Balanites aegyptiaca	0.5 to 2m :	
	3) Maerua crassifolia	0.5 to 2m :	30%
	4) Acacia flava	0.5 to 1.5m:	
	5) Calothropis procera	2m :	
Average range	5 to 50 m and 5 m in places		
Herbaceous	Rare Leptadenia spartium 0.5 to 1 m Stumps of Stipagrostis pungens 20 to 50 cm	Percentage of overall coverage 15%	
General state of grass land	- Bad state - Area of degradation about 700m		

Observation Date: 06/12/1980 Department Moudjeria

Region: Tagant 09

Location: Moudjeria

Transect: South West B N° 20

Topography	Flat ground with fault (Area of contact between rag and mountains)	
State of soil surface	Clayey and stony soil denuded by the erosion	
I Ligneous	Species	Height Proportio
	1) Acacia raddiana	0.2 to 0.5m 90%
	2) Balanites aegyptiaca	3m 10%
Average range	In contact with the mountain: 1 to 5m Outwardly of outlet: 40m	
II Herbaceous	1) "Aoueiouir" (Moor) is very frequent 2) Leptadenia spartium 20 to 50 cm	Percentage of overall coverage 5%
General state of grass land	-Grazing land in regeneration (Acacia raddiana), fairly mediocre presently - Very degraded area, broken by an alignement of dunes along about 200m	

Observation Date: 06/14/1980 Department Moudjeria

Region: Tagant 09

Location: N' Beika N° 21

Transect: East A

Topography	Tamourt-en-naaj valley surrounded by the summits of Tagant (sandstone massive)	
State of soil surface	Silty clay soil cracked after decrease of water of rain saison (good agricultural soil)	
I Ligneous	Species	Height Proportio
	1) Acacia nilotica 2) Balanites aegyptiaca 3) Acacia raddiana	0.2 to 6m 70% 0.5 to 3m : 30% 1.5 to 2m :
Average range	1 to 6m	
I Herbaceous	1) Indigofera: 0.2 to 0.5 m (very close) 2) Leptadenia spartium	Percentage of overall coverage : 40%
General state of grass land	-Grazing land imbricated with pieces of reclaimed land - No area of degradation	

Observation Date: 06/22/1980 Department Moudjeria

Region: Tagant 09

Location: N'Beika

Transect: North B N° 21

Topography	Tamourt-en-naaj valley surrounded by the summits of Tagant		
State of soil surface	Silty clay compressed soil		
I Ligneous	Species	Height	Proportion
	1) Acacia nilotica	7m	50%
	2) Balanites aegyptiaca	0.5 to 3m	50%
verage range	5 to 10m		
II Herbaceous	1- Indigofera sp 0.2 to 0.5 m 2- herbaceous tufts (" linit c'houar"in Moor): 0.4 to 0.8 m	Percentage of overall covera 20%	
General state of grass land	- In this valley the grove of palms alternates with the pieces of crops - Weak herbaceous grazing land - No area of visible degradation		

Observation Date: 06/15/1980 Department Rachid

Region: Tagant 09

Location: Aghlambit

Transect: East A N° 22

Topography	River valley (Oued el Abiod) bordded in East by the Tagant tableland
State of soil surface	Rocky and bare soil at the top of the slope, in contrast sandy soil in the River valley

[Ligneous	Species	Height	Proportion
	1) Acacia flava	0.5 to 3m	40%
	2) Acacia raddiana	0.5 to 6m	30%
	3) Balanites aegyptiaca	0.2 to 3m :	
	4) Maerua crassifolia	0.5 to 3m :	
	5) Boscia senegalensis	0.5 to 2m :	
	6) Capparis decidua	0.5 to 1m :	30%
	7) Euphorbia balsamifera	1 to 2m :	
	8) Acacia seyal	1 to 2m :	
	9) Calothrppis procera	0.5 to 1m :	
	10) Zizyphus mauritiana	3m :	
erage range	2 to 10 m		

Herbaceous	Panicum turgidum 0.20 to 0.50m(very thin) Percentage of overall coverage 5 %
General state of grass land	- Grazing land in good state and on a way to regeneration - Area of degradation about 1,000m(without trees)

Observation Date: 06/15/1980 Department Rachid

Region: Tagant 09

Location: Aghlambit

Transect: North B N° 22

Topography	Flat rag , very rocky and clayey soil of North side of El Abiod river
State of soil surface	Pebbly soil with outcrop of rocky blocks More or less hard clay silty soil

I Ligneous	Species	Height	Proportion
	1) Acacia raddiana	0.5 to 6m	60%
	2) Maerua crassifolia	0.2 to 1m :	
	3) Capparis decidua	1 to 2m :	
	4) Balanites aegyptiaca	0.5 to 4m :	
	5) Boscia senegalensis	0.5 to 1m :	40%
	6) Calothropis procera	0.2 to 3m :	
	7) Salvadora persica	2 to 3m :	
Average range	10 to 20m and over 20m in places		

II Herbaceous	Rare tufts of Panicum turgidum: 0.20m	Percentage of overall coverage ± 20%
General state of grass land	- Area of regeneration but excessively browsed and degraded by cattle - Cleared area with large glades - Area of intensive degradation over 1,000m	

Observation Date: 06/15/1980 Department Tidjikja

Region: Tagant 09

Location: Tidjikja

Transect: North East A N° 23

Topography	Wide and alluvial sandy valley of Tidjikja River bordered by sandstony tablelands of Tagant		
State of soil surface	Sandy along the river; rocky with sandy overlappings on the border tableland		
I Ligneous	Species	Height	Proportion
	1) Balanites aegyptiaca	0.5 to 2m	40%
	2) Acacia raddiana	0.5 to 3m :	
	3) Euphorbia balsamifera	0.5 to 1.5m:	60%
	4) Calothropis procera	50cm	
	5) Maerua crassifolia	1 to 2m	
Average range	2 to 20m		
I Herbaceous	- Herbaceous species ("Tendfa" in Moor). 0.2 to 0.8m -"Ashrek":0.1 to 0.8m	Percentage of overall coverage	40%
General state of grass land	- Pasture of young bushes very degraded - Area of degradation (cutting, cattle) along nearly 500m		

Observation Date: 06/17/1980 Department Tidjikja

Region: Tagant 09

Location: Tidjikja

Transect: South West B N° 23

Topography	Sandy flat scope with small rocky outcrops		
State of soil surface	More or less fixed sandy soil onto rocky substrat		
I Ligneous	Species	Height	Proportion
	1) Euphorbia balsamifera	0.2 to 0.8m	60%
	2) Calothropis procera	0.2 to 2m :	
	3) Balanites aegyptiaca	0,2 to 1m :	
	4) Boscia senegalensis	0.2 to 1.5m :	40%
	5) Acacia raddiana	0.2 to 1.5m :	
	6) Maerua crassifolia	0.5 to 3m :	
verage range	1 to 5m		
: Herbaceous	"Tendfa"; 0.1 to 1.5m - Leptadenia spartium: 0.3 to 0.8m - Panicum turgidum: 0.1 to 0.2 m	Percentage of overall coverage 20%	
neral state grass land	- This grazing land with bush dominant is qualitatively poor and degraded - Area of degradtion about 1000 m (cattle and cutting)		

Observation Date: 06/18/1980 Department Boumdeid

Region: Assaba 03

Location: Boumdeid

Transect: East A N° 24

Topography	Leveled dunes, relief slightly hilly bordered in West by Tag nt		
State of oil surface	Sandy soil on olayey substrat		
I Ligneous	Species	Height	Proportion
	1) Balanites aegyptiaca	0.5 to 2m	40%
	2) Acacia raddiana	0.5 to 4m :	
	3) Maerua crassifolia	1 to 5m :	
	4) Boscia senegalensis	2 to 4m :	60%
	5) Calothropis procera	2 to 4m :	
	6) Capparis decidua	1 to 3m :	
Average range	5 to 20m		
II Herbaceous	- Tufts of Panicum turgidum 0.1 to 05m - Leptadenia spartium 0.5m	Percentage of overall coverage < 5%	
General state of grass land	- Very important pruning in this pasture with Acacia raddiana dominant -Area of intensive degradation alog 400 to 500m		

Observation Date: 06/18/1980 Department Boumdeid

Region: Assaba 03

Location: Boumdeid

Transect: South West B N° 24

pography	Sandy slope bordering south of the Boumdeid river		
ate of soil rface	Sandy soil more or less in motion		
Ligneous	Species	Height	Proportion
	1) Acacia raddiana	0.5 to 2m	50%
	2) Balanites aegyptiaca	0.5 to 2m :	20%
	3) Euphorbia balsamifera	0.5 to 1m :	
Average range	2 to 15m in places, 40m for the rest		
I Herbaceous	- Panicum turgidum: 0.2 to 0.8 m - Leptadenia spartium: 50cm - Some dispersed mulch: 0.05m - (dry graminieous roots)	Percentage of overall coverage < 5%	
eneral state f grass land	- Most of Acacia raddiana is dead, the rest of this species is subject of excessive cutting which is used to close the neighbouring crops - Area of degradation about 1,000m		

Observation Date: 06/19/1980 Department Kiffa

Region: Assaba 03

Location: Kiffa

Transect: North West A N° 25

Topography	Dune relief		
State of soil surface	Slightly fixed sandy soil		
I Ligneous	Species	Height	Proportion
	1) Calothropis procera	0.5 to 2m	80%
	2) Acacia raddiana	0.5 to 8m	20%
	3) Balanites aegyptiaca	0.5 to 2m	
verage range	1 to 10 m , sometimes over 20m		
I Herbaceous	Rare Leptadenia spartium 0.5 m	Percentage of overall coverage 5%	
General state of grass land	- Very degraded pasture: cutting of Calothropis procera in order to roofing; Pruning of Balanites aegyptiaca and acacia raddiana for cattle - Area of degradation: about 800m covered by calothropis procera		

Observation Date: 06/19/1980 Department Kiffa

Region: Assaba 03

Location: Kiffa

Transect: South West B N° 25

Topography	Pebbly rag (flat surface) in alternation with large oued basins
State of soil surface	Clayey soil, pebbly in the rag and silty clayey in the drainage basin of oued

Lignoeous	Species	Height	Proportion
	1) Acacia raddiana	0.5 to 2m	40%
	2) Balanites aegyptiaca	0.2 to 3m	30%
	3) Zizyphus mauritiana	0.2 to 0.8m :	
	4) Aberua crassifolia	0.5 to 1m :	30%
	5) Acacia flava	1m :	
	6) Acacia seyal	2m :	

age range	On the rag: 5 to 10m In the oued: 1 to 3m

Herbaceous	Percentage of overall con
	None

eral state grass land	- This is an area of regeneration par excellence especially in the drainage basin of the oued - Pasture with no degradation - no cutting for cattle - Area of degradation about 1.000m with Calothropis procera

Observation Date: 06/20/1980 Department Kankossa

Region: Assaba 03

Location: Kankossa

Transect: South West A N° 26

Topography	Sandy plain of East border of Oued of Kankossa (leveled dunes overhanging Kankossa)		
State of soil surface	More or less fixed sandy soil alternating with clayey depression area on the border of Kankossa		
I Ligneous	Species	Height	Proportion
	1) Balanites aegyptiaca	0.5 to 6m	40%
	2) Combretum glutinosum	2 to 6m	20%
	3) Acacia senegal	0.5 to 2m :	
	4) Bauhinia rufescens	2 to 4m :	40%
	5) Zizyphus mauritiana	1 to 4m :	
	6) Acacia raddiana	0.5 to 1m:	
	7) Hyphaene thebaica		
verage range	3 to 10m		
I Herbaceous	None	Percentage of overall coverage	
eneral state f grass land	- Aerial grazing land subject to cutting and pruning for cattle (A nomad was found cutting a branch) - Degraded area about 1,000m		

bservation Date: 06/20/1980 Department Kankossa

egion: Assaba 03

ocation: Kankossa

ransect: South WEst B N° 26

opography	Alternation of dunes		
tate of soil urface	Slightly fixed sandy soil on dunes Brown soil covered with sandy slabs in interdunes		
Ligneous	Species	Height	Proportion
	1) Balanites aegyptiaca	0.5 to 6m	50%
	2) Combretum glutinosum	1 to 6m	30%
	3) Bauhinia rufescens	2 to 3m :	
	4) Calothropis procera	0.2 to 2m :	30%
	5) Acacia nilotica	6m :	
	6) Acacia senegal	2 to 6m :	
erage range	5 to 20m		
Herbaceous	"Sarsar" in Moor 0.5m	Percentage of overall coverage ≤5%	
neral state grass land	-- Pruning in addition to many dry species: Balanites aegyptiaca and Combretum glutinosum - Relatively degraded pasture -- Area of degradation about 1,000m		

Observation Date: 06/20/1980 Department Kankossa

Region: Assaba 03

Location: Ain Tess

Transect: East A N° 27

Topography	Rocky ridges (sanstone) in alternation with large low grounds of Affolé
State of soil surface	Clayey soils in low ground . Very rocky on ridges and slope

I Ligneous	Species	Height	Proportion
	1) Combretum glutinosum	0.5 to 6m	80%
	2) Sclerocarya birrea	6m :	
	3) Acacia senegal	0.5 to 5m :	
	4) Zizyphus mauritiana	1 to 3m :	
	5) Acacia nilotica	1 to 3m :	
	6) Balanites aegyptiaca	0.5 to 5m :	
	7) Bauhinia reticulata	1 to 3m :	20%
	8) Sterculia tomentosa	6 to 8m :	
	9) Pterocarpus erinaceus	3 to 6m :	
	10) Guiera senegalensis	1 to 2m :	
	11) Boscia senegalensis	1 to 2m :	
	12) Grewia bicolor	1m :	
	13) Adansonia digitata	8m :	
	14) Adenium sp	1m :	
	15) "Kahkah" and "Base"	1m :	
Average range	1 to 15m		

II Herbaceous	a lot of mulch Percentage of overall coverage : 20%
General state of grass land	- Tree bushy pasture in relatively good state but there is a lot of dry trees - No visible cutting

Observation Date: 06/20/1980 Department Kankossa

Region: Assaba 03

Location: Ain Tess

Transect: North west B N° 27

Topography	Hllowed and eroded surface on the plateland of Affolé		
State of soil surface	Clayey soil with rocky outcrops here and there (rocks, blocks, pebblies)		
I Ligneous	Species	Height	Proportion
	1) Combretum glutinosum	0.5 to 6m	70%
	2) Sclerocarya birrea	5m	:
	3) Bauhinia reticulata	5 to 6m	:
	4) Commiphora africana	0.5 to 3m	:
	5) Acacia senegal	0.5 to 6m	: 30%
	6) Ziziphus mauritiana	2m	:
	7) Balanites aegyptiaca	0.5m	:
	8) Sterculia tomentosa	5m	:
	9) Adansonia digitatata	6m	:
	10) Hyphene thebaica	7m	:
	11) Adenium sp	2m	:
Average range	2 to 10m		
II Herbaceous	None	Percentage of overall coverage	
General state of grass land	- Pasture with Combretum glutinosum dominant - Over 40% of Sclerocarya is dead because of drought. - No visible cutting - No area of degradation		

Observation Date: 06/21/1980 Department Barkeol

Region: Assaba 03

Location: Laouessi

Transect: North West N° 28

Topography	Rag of Aftout: flat ground in North of Laouessi river with a lot of gullies		
State of soil surface	Pebbly and clayey soil		
I Ligneous	Species	Height	Proportion
	1) Balanites aegyptiaca	0.2 to 4m	80%
	2) Acacia flava	0.5m	:
	3) Zizyphus mauritiana	2 to 3m	:
	4) Bauhinia rufescens	0.5 to 2m	: 20%
	5) Acacia senegal	0.5 to 2m	:
	6) Capparis decidua	2 to 3m	:
	7) Acacia raddiana	6m	:
Average range	1 to 20m		
II Herbaceous	None	Percentage of overall coverage	
General state of grass land	-Tree clad pasture whose many species are dead because of the drought: Acacia flava, Acacia senegal and Balanites aegyptiaca - Area of degradation along about 3,000m		

Observation Date: 06/21/1980 Department Barkeol

Region: Assaba 03

Location: Laouessi

Transect: West B

Topography	North edge of Laouessi River disequed by numerous gullies		
State of soil surface	Clayey brown soil		
[Ligneous	Species	Height	Proportion
	1) Acacia flava	0.5 to 6m	50%
	2) Balanites aegyptiaca	0.5 to 6m	
	3) Bauhinia rufescens	0.5 to 3m	40%
	4) Zizyphus mauritiana	0.5 to 2m	
	5) Calothropis procera	0.5 to 1m	
	6) Capparis deciduo	1 to 2m	10%
	7) Bauhinia reticulata	2m	
	8) Acacia seyal	0.5m	
erage range	1 to 2m and rarely 1 to 10 m		
Herbaceous	None	Percentage of overall coverage	
neral state grass land	- This domain, situated in a vicinity of the village and Laouessi river, has been reclaimed for rainfed crops, that is why all the cut stumps have shots resulting in an important regeneration (all species) Area of reclaiming and degradation along about 1,000m		

Observation Date: 06/23/1980 Department Barkeol

Region: Assaba 03

Location: Barkeol

Transect: North West A N° 29

Topography	Flat area of Aftout with gullies		
State of soil surface	Sandy soil on clayey substrat		
I Ligneous	Species	Height	Proportio
	1) Balanites aegyptiaca	0.5 to 6m	40%
	2) Acacia senegal	0.5 to 3m	30%
	3) Bauhinia rufescens	0.5 to 1m :	30%
	4) Acacia flava	2m :	
Average range	1 to 20m		
II Herbaceous	soil covered with mulch here and there	Percentage of overall coverage 5%	
General state of grass land	- Degraded grazing land (cutting for cattle and pruning) - Degradation area along about 500m		

Observation Date: 06/22/1980 Department Barkeol

Region: Assaba 03

Location: El Ghabra

Transect: West A N° 30

Topography	Plain of El Ghabra oued with a lot of incised gullies		
State of soil surface	Solid clayey soil		
I Ligneous	Species	Height	Proportion
	1) Balanites aegyptiaca	0.5 to 2m	50%
	2) Acacia flava	0.5	40%
	3) Acacia nilotica	6m	10%
	4) Zizyphus mauritiana	0.2m	
erage range	5 to 10m and 20 to 50m here and there		
I Herbaceous	Indigofera sp: o.2 to 0.5m Some mulch of sorghum	Percentage of overall coverage 5%	
eneral state f grass land	- Very degraded grazing land: young shots are browsed - Reclaiming - Area of rainfed cultivation - Very degraded area all over the transect (3miles)		

Observation Date: 06/22/1980 Department Barkeol

Region: Assaba 03

Location: El Ghabra

Transect: East B N° 30

Topography	Pebbly rag with sandy overlappings here and there- Alternation of flat lands and sandy low grounds		
State of soil surface	Clayey soil. Pebbly and sandy in low ground of gullies		
I Ligneous	Species	Height	Proportio
	1) Balanites aegyptiaca	0,5 to 2m	40%
	2) Acacia flava	0.2 to 1m	20%
	3) Zizyphus mauritiana	1 to 2m	40%
	4) Bauhinia rufescens	0.5 to 1m	
	5) Acacia seyal	2m	
	6) Capparis decidua	1 to 3m	
Average range	5 to 20m		
II Herbaceous	Indigofera 0.5m	Percentage of overall coverage	< 5%
General state of grass land	- Grazing land in regeneration by stumps - Very degraded area all over the transect		

bservation Date : 07/10/1980 Department Tamchakett

egion: Hodh el Gharbi 02

ocation: Tamchakett

ransect: East A N° 31

opography	Area of dunes alternating with depressions		
tate of oil surface	More or less fixed sandy soil		
Ligneous	Species	Height	Proporti
	1) Acacia raddiana	0.5 to 4m	60%
	2) Balanites aegyptiaca	0.5 to 3m	20%
	3) Acacia nilotica	6 to 10m	:
	4) Maerua crassifolia	0.5 to 6m	:
	5) Capparis decidua	3m	:
	6) Zizyphus mauritiana	3 to 5m	: 20%
	7) Acacia flava	1 to 3m	:
	8) Boscia senegalensis	1 to 3m	:
	9) Commiphora africana	3m	:
erage range	1 to 5m and over 30m here and there		
Herbaceous	Rares panicum turgidum 0.1m	Percentage of overall coverage < 5%	
neral state grass land	- Acacia raddiana : cut and rooted up - Very browsed Boscia, Balanites and Maerua - Considerable drying up of Commiphora africana - Area of degradation along about 500m. (bare soil)		

Observation Date: 07/10/1980 Department Tamchakett

Region: Hodh el Gharbi

Location: Tamchakett

Transect: North West B N° 31

Topography	Sandy soils more or less flat: Oued border		
State of soil surface	Sandy soil in mobilization.		
I Ligneous	Species	Height	Proporti
	1) Acacia raddiana	0.5 to 6m	50%
	2) Balanites aegyptiaca	0.5 to 6m	20%
	3) Maerua crassifolia	1 to 6m	—:
	4) Acacia nilotica	2 to 6m	:
	5) Zizyphus mauritiana	4 to 8m	: 30%
	6) Acacia flava	3m	:
	7) Commiphora africana	3m	:
Average range	5 to 15 m		
II Herbaceous	None	Percentage of overall coverage	
eneral state f grass land	- Very grazed and pruned Acacia raddiana - Important number of decimaded species - A lot of trees upset by wind - Very degraded grazing land - Area of severe degradadation along 600m (sand movement, cutting, cattle)		

Observation Date: 07/11/1980 Department Aïoun el Atrous

Region: Hodh el Gharbi

Location: Aïun el Gharbi

Transect: South West A N° 32

Topography	Sandy flat soil with rocky levellings		
State of soil surface	Remobilized sandy soils		
Ligneous	Species	Height	Proportion
	1) Acacia raddiana	0.5 to 3m	80%
	2) Balanites aegyptiaca	0.5 to 2m	:
	3) Acacia senegal	0.5 to 3m	:
	4) Acacia flava	1 to 3m	:
	5) Calothropis procera	0.5 to 1m	: 20%
	6) Maerua crassifolia	1 to 2m	:
	7) Zizyphus mauritiana	1 to 3m	:
	8) Commiphora africana	3m	:
verage range	1 to 5m		
Herbaceous	None	Percentage of overall coverage	
neral state grass land	-Calothropis procera dominant in the area near town on an strip of about 1,000m -Very browsed Maerua crassifolia - Old cuttings for cattle and enclosures		

Observation Date: 07/11/1980 Department: Aïoun El Atrouss

Region: Hodh el Gharbi 02

Location: Aïoun El Atrouss

Transect: North West B N° 32

Topography	Flat in the sandstone of Aftout		
State of soil surface	Sandy and clayey soil		
I Ligneous	Species	Height	Proporti
	1) Euphorbia balsamifera	0.5 to 3m	30%
	2) Acacia raddiana	0.5 to 8m	20%
	3) Acacia flava	0.5 to 3m	
	4) Commiphora africana	2 to 3m	
	5) Boscia senegalensis	0.5 to 3m	
	6) Acacia senegal	0.5 to 3m	
	7) Zizyphus mauritiana	1 to 2m	50%
	8) Bauhinia rufescens	1m	
	9) Maerua crassifolia	1m	
	10) Balanites aegyptiaca	0.5 to 1m	
	11) Calothropis procera	0.5m	
	12) Grewia tenax	0.5 to 1m	
	13) Adansonia digitata	6m	
Average range	10 to 20 m		
II Herbaceous	None	Percentage of overall coverage	
General state of grass land	- Shrubby grazing land slightly degraded by pruning and cutting - Area of degradation of Calothropis along about 1,000m		

bservation Date: 07/18/1980 Department Koboni

egion: Hodh el Gharbi

ocation: Koboni

ransect: East A N° 33

opography	Relatively flat surface weakly cut by an oued	
tate of soil surface	Clayey soil with sandy overlappings scattered (fixed)	
Ligneous	Species	Height Proportion
	1) Balanites aegyptiaca	0.5 to 8m 50%
	2) Combretum glutinosum	1 to 6m 30%
	3) Calothropis procera	0.5 to 3m
	4) Acacia senegal	0.5 to 2m
	5) Bauhinia rufescens	0.5m 20%
	6) Adansonia digitata	10m
	7) Acacia albida	1m
rage range	1 to 10m	
Herbaceous	None Percentage of overall coverage	
neral state grass land	- Very frequent cutting and pruning - Area of reclaiming - Very browsed young trees - Degraded grazing land - Area of degraded vegetation with Calothropis procera along about 1,500m	

Observation Date: 07/19/1980 **Department** Koboni

Region: Hodh el Gharbi

Location: Touil

Transect: West - N° 34

Topography	Rather large and flat bed of oued.		
State of soil surface	Clayey soil with sandy slabs.		
I Ligneous	Species	Height	Proportion %
	1. Acacia senegal	1 to 3m	40%
	2. Balanites aegyptiaca	1 to 7m	30%
	3. Guiera senegalensis	1 to 1.5m	:
	4. Combretum glutinosum	2 to 5m	:
	5. Zizyphus mauritiana	0.5 to 2m	:
	6. Grewia bicolor	2 to 3m	:
	7. Bauhinia rufescens	0.5m	:
	8. Mytragina inermis	2m	:
	9. Acacia nilotica	0.5m	:
	10. Dalbergia melanoxylon	3m	:
Average range	10 m		
II Herbaceous	Traces of mulch	Percentage of overall coverage < 5%	
General state of grass. land	- Cutting and pruning for reclaiming. - Rain fed cultivation. A lot of gumtrees pruning for cattle. - Grazing land is modified by cutting. - Area of degradation all over the transect.		

Observation Date: 07/18/1980 Department Koboni

Region: Hodh el Gharbi

Location: Koboni

Transect: South West B N° 33

Topography	Clayey and pebbly rag	
State of soil surface	Pebbly and clayey soil	
I Ligneous	Species	Height Propor
	1) Balanites aegyptiaca	0.5 to 6m 40
	2) Acacia seyal	0.5 to 2m 30
	3) Acacia senegal	0.5 to 1m — : 30
	4) Bauhinia rufescens	0.5m — :
Average range	5 to 10m	
II Herbaceous	-Rare stubbles: 0.2m Rare leptadenia spartium: 0.5m Percentage of overall cover <5%	
General state of grass land	- Area of degradation with Acacia Seyal and Balanites aegy ca dominant - Presence of animals (goats) - Fields of rainfed cultiva - Slightly degraded grazing land - Area of degradation along about 1,500m	

Observation Date: 07/ 19/1980 **Department** Koboni

Region: Hodh el Gharbi

Location: Touil

Transect: North - B N° 34

Topography	Depression of oued and sandy overlappings of weak amplitude(small differences in level)		
State of soil surface	Clayey soil with sandy slabs in places.		
I Ligneous	Species	Height	Proportion %
	1. Guiera senegalensis	0.5m	30
	2. Grewia bicolor	1m	20
	3. Zizyphus mauritiana	0.5m	+
	4. Gum tree	0.5 to 4m	:
	5. Acacia nilotica	0.5 to 1m	:
	6. Balanites aegyptiaca	0.5 to 3m	:
	7. Combretum glutinosum	6m	:
	8. Acacia flava	2m	: 50
	9. Sclerocarya birrea	6m	:
	10. Bauhinia rufescens	0.5m	:
	11. Acacia seyal	1m	:
	12. Adansonia digitatata	8m	:
Average range	10 m		
II Herbaceous	None	Percentage of overall coverage	
General state of grass. land	- Severe reclaiming : fields of rainfed cultivation - Degraded grazing land. -Wandering animals. - Area of degradation along whole transect.		

Observation Date: 07/12/1980 **Department** Timbe. dra

Region: Hodh el Chargui

Location: Tim bedra

Transect: East - A N° 35

Topography	Plain and depression of Tamourt valley		
State of soil surface	Sandy and clayey soil in the Tamourt valley, on the summits and the slopes.		
I Ligneous	Species	Height	Proportion %
	1. Acacia raddiana	0.5 to 6m	70%
	2. Balanites aegyptiaca	0.5 to 5m	
	3. Acacia seyal	1 to 3m	
	4. Acacia senegal	0.5 to 1m	
	5. Commiphora africana	3m	30%
	6. Calothropis procera	1m	
	7. Acacia nilotica	5 to 6m	
Average range	5 to 20 m		
II Herbaceous	None	Percentage of overall coverage	
General state of grass. land	- Degraded Balanites because of animals. - Cutting is more or less frequent. - Area of degradation along whole transect (cuttings and animals).		

Observation Date: 07/12/1980 **Department** Timbedra

Region: Hodh el Chargui - 01

Location: Timbedra

Transect: South West - B N° 35

Topography	Sandy plain slightly undulating.		
State of soil surface	Sandy soil with clayey places.		
I Ligneous	Species	Height	Proportion %
	1. Acacia raddiana 2. Balanites aegyptiaca 3. Acacia senegal 4. Commiphora africana 5. Acacia seyal 6. Calothropis procera 7. Acacia nilotica	0.5 to 6m 0.5 to 3m 0.5 to 2m 0.5 to 2m 2 to 3m 0.5 to 1m 6m	60 40
Average range	1 to 10 m and 20 m in places.		
II Herbaceous	None	Percentage of overall coverage	
General state of grass. land	- Balanites, gum trees and commiphora are browsed by animals. - Calothropis cut by the inhabitants. - Degraded area along whole transect (cutting and animals).		

Observation Date: 07/13/1980 **Department** Nema

Region: Hodh el Chargui - 01

Location: Nema

Transect: West N° 36

Topography	Rag of piedmont of Dhar Nema; slight slope of piedmo		
State of soil surface	Clayey and pebbly soil.		
I Ligneous	Species	Height	Proportion %
	1. Acacia flava 2. Acacia raddiana 3. Balanites aegyptiaca 4. Maerua crassifolia 5. Acacia seyal	0.5 to 3m 1 to 2m 0.5 to 1m 1 to 1.5m 0.5 to 2m	80 -: : : _: 20
Average range	5 to 10 m		
II Herbaceous	None	Percentage of overall coverage	
General state of grass. land	- A lot of trees have not dead leaves. - Very intensive cutting and pruning. - Some Acacia flava knocked down by wind. - Degraded grazing land. - Area of degradation along about 2,000 m.		

Observation Date: 07/14/1980 **Department** Oualata

Region: Hodh el Chargui

Location: Oualata

Transect: North West A N° 37

Topography	Oued valley surrounded by rocky escarpements of Dhar Oualata (sandstone).		
State of soil surface	Sandy soil in the oued valley.		
I Lignaeous	Species	Height	Proportion %
	1. Acacia raddiana 2. Balanites aegyptiaca 3. Acacia flava 4. Maerua crassifolia 5. Euphorbia balsamifera 6. Combretum glutinosum	0.5 to 8m 0.5 to 8m 2 to 3m 0.5 to 1m 2m 2m	70 30
Average range	5 to 10 m		
II Herbaceous	1-Leptadenia spartium: 0.5 to 1m 2-Panicum turgidum: 0.2 to 0.5m	Percentage of overall coverage < 5%	
General state of grass. land	- All species severely browsed and degraded excepted big trees (8m). Degraded grazing land. - Barks pruning and pulling up especially Acacia raddiana and Acacia flava are reported. - Area of degradation along whole transect.		

Observation Date: 07/14/1980 **Department** Ouallata

Region: Hodh el Chargui - 01

Location: Oualata

Transect: South West B N° 37

Topography	Same as transect A		
State of soil surface	Sandy soil with clayey and peboly areas.		
I Ligneous	Species	Height	Proportion %
	1. Acacia flava 2. Balanites aegyptiaca 3. Acacia raddiana 4. Maerua crassifolia 5. Boscia senegalensis 6. Euphorbia balsamifera	1 to 3m 0,5 to 8m 0.5 to 3m 1 to 2m 0.5 to 2m 1m	60
Average range	5 to 10 m		
II Herbaceous	Leptadenia spartium 0.5m	Percentage of overall coverage <5%	
General state of grass. land	- Shrubby area - Young species are browsed. - Some Maerua crassifolia are uprooted by wind. - Degraded grazing land. -Area of degradation along whole transect.		

Observation Date: 07/16/1980 **Department** Bassikounou

Region: Hodh el Chargui - 01

Location: Bassikounou

Transect: North West N° 38

Topography	Plain.		
State of soil surface	Very compact clayey soil.		
I Ligneous	Species	Height	Proportion %
	1. Acacia raddiana	0.2 to 3m	40
	2. Acacia flava	0.2 to 3m	30
	3. Commiphora africana	3m	
	4. Boscia senegalensis	0.5 to 1m	
	5. Acacia seyal	2 to 3m	
	6. Acacia senegal	0.5 to 3m	30
	7. Maerua crassifolia	0.5 to 1m	
	8. Balanites aegyptiaca	0.3 to 2m	
Average range	1 to 10 m and 10 m in places.		
II Herbaceous	- Dense tufts - Cymbopogon Scholnanthub	Percentage of overall coverage ±30%	
General state of grass. land	- 20% of Commiphora are dead of which some knocked dow - Dense shrubby grazing land with a glade: young acacia are browsed - Slightly degraded grazing land (no cutting) - Area of degadation along 300 m.		

Observation Date: 07/16/1960 **Department** Bassikounou

Region: Hodh el Chargui - 01

Location: Bassikounou

Transect: South East B N° 38

Topography	Alternation of low sand dunes and clayey plains.		
State of soil surface	Clayey soil with fixed sand.		
I Ligneous	Species	Height	Proportion %
	1. Acacia senegal 2. Acacia raddiana 3. Balanites aegyptiaca 4. Boscia senegalensis 5. Maerua crassifolia 6. Pterocarpus luscens	0,5 to 3m 0,5 to 2m 0,2 to 1m 0,5 to 2m 0,5 to 1m 1 to 2m	30 70
Average range	5 to 10 m		
II Herbaceous	-"Aghoum" in (Moor): 0,5m - Mulch of Cenchrus biplorus: 0.3 m	Percentage of overall coverage ±10%	
General state of grass. land	- Grazing land with gum trees dominant. - Some pterocarpus are dried standing up. - More or less degraded grazing land. - Area of degradation along 600 m		

Observation Date: 07/16/1980 **Department** Amourj

Region: Hodh el Chargui -01

Location: Abdel Bagrou

Transect: South - A N° 39

Topography	Rather flat area of oued spreading (small depression)		
State of soil surface	Very heavy clayey soil with sandy slabs in places		
I Ligneous	Species	Height	Proportion %
	1. Zizyphus mauritiana 2. Acacia seyal 3. Acacia raddiana 4. Acacia flava 5. Acacia senegal 6. Acacia nilotica 7. Balanites aegyptiaca 8. Bauhinia rufescens	0,5 to 6m 0,5 to 2m 0,5 to 3m 0,5 to 3m 0,5 to 3m 1 to 6m 0,5 to 4m 1 to 2m	50% 30%
Average range	1 to 5 m and over 20m in places		
II Herbaceous	Rare Leptadenia Spartium: 0,5m	Percentage of overall coverage <5%	
General state of grass. land	- Acacia seyal , Acacia nilotica and Zizyphus mauritiana are cut for cattle and zeribas. - Very browsed bush. - Considerable grazing land but victim of cutting. - Area of degradation along 1,000m		

Observation Date: 07/16/1980 **Department** Amourj

Region: Hodh el Chargui

Location: Abdel Bagrou

Transect: East - B N° 39

Topography	Same as transect A		
State of soil surface	Compact clayey soil in low ground and fixed sandy soil on oued borders.		
I Ligneous	Species	Height	Proportion %
	1. Acacia flava 2. Acacia nilotica 3. Acacia raddiana 4. Acacia senegal 5. Acacia seyal 6. Balanites aegyptiaca 7. Zizyphus mauritiana	0,5 to 2m 0,5 to 3m 0,5 to 3m 0,5 to 2m 3m 0,5 to 3m 2m	60
Average range	5 to 10 m		
II Herbaceous	Mulch rests of Cenchrus biflorus	Percentage of overall coverage < 5%	
General state of grass. land	- Area of pruning for cattle - Wandering animals - Degraded grazing land - Area of degradation along about 1,000m		

Observation Date: 07/17/1980 **Department** Timbeidra

Region: Hodh el Chargui

Location: Bousteila

Transect: North West B N° 40

Topography	Oued basin		
State of soil surface	Clayey silty soil		
I Ligneous	Species	Height	Proportion %
	1. Bauhinia rufescens 2. Comoretum glutinosum 3. Acacia nilotica 4. Balanites aegyptiaca 5. Calothropis procera 6. Zizyphus mauritiana 7. Acacia albida	0,5 to 1m 0,5 to 6m 0,5 to 6m 0,5 to 1m 0,5 to 2m 1 to 6m 8m	60 40
Average range	5 to 10 m and 40 m in the end of the transect		
II Herbaceous	None	Percentage of overall coverage	
General state of grass. land	- Degraded soil - trampled on and gullied. - Intensive cutting of Zizyphus and Combretum glutinosum - Reclaimed area with occasional flooding - Degraded grazing land - Area of degradation along about 1,000m		

Observation Date: 07/17/1980 **Department** Timbeidra

Region: Hoah el Chargui -01

Location: Bousteila

Transect: East A N° 40

Topography	Plain		
State of soil surface	Clayey soil with sandy overlappings in places		
I Ligneous	Species	Height	Proportion %
	1. Combretum glutinosum	0,5 to 5m	60
	2. Acacia nilotica	0,5 to 8m	
	3. Balanites aegyptiaca	0,5 to 2m	
	4. Bauhinia rufescens	0,5 to 1m	20
	5. Acacia senegal	0,5m	
	6. Calothropis procera	0,5 to 1m	
	7. Zizyphus mauritiana	0,5 to 5m	
Average range	5 to 10 m		
II Herbaceous	None	Percentage of overall coverage	
General state of grass. land	- Degraded bush - Cut Combretum (reclaiming) is in regeneration - Rainfed land cultivation - Degraded grazing land - Area of degradation along 1,000m.		

Observation Date: 06/22/1980 **Department** Mederdra

Region: Trarza 06

Location: Djechmajek

Transect: Pastoral well N° 2

Topography	System of Trarza dunes, undulating: alternation of dunes and depressions (gouds)		
State of soil surface	Sandy soil more or less fixed on dunes, sandy clay soil in the goud		
I Ligneous	Species	Height	Proportion %
	1. Acacia raddiana 2. Balanites aegyptiaca 3. Acacia senegal	0,5 to 3m 0,5 to 8m 1 to 3m	50 30 20
Average range	1 to 5 m		
II Herbaceous	None	Percentage of overall coverage	
General state of grass. land	- Very clear area of degradation of 100m - Cultivation lands surrounded by zeribas Degraded grazing land		

Observation Date: 06/23/1980 **Department** Mederdra

Region: Trarza - 06

Location: Rach Telly

Transect: Pastoral well-South West N° 3

Topography	Depression between dunes (goud) surrounded by dunes (system of Trarza)		
State of soil surface			
I Ligneous	Species	Height	Proportion %
	1. Acacia senegal	0,5 to 2m	50
	2. Acacia seyal	1 to 4m	20
	3. Balanites aegyptiaca	0,5 to 6m	20
	4. Acacia raddiana	0,5 to 2m	
	5. Tamarindue indica	10m	10
	6. Calothropis procera	1,5m	
Average range	2 to 20m		
II Herbaceous	Mulch of Cenchrus bif Leptadenia spartium: 0,50 m max.	Percentage of overall coverage <10%	
General state of grass. land	- Area of degradation around the well: 500m - Shrubby area with rare big trees scatered around - Presence of former cultivation lands - More or less degraded grazing lands		

Observation Date: 05/18/1980 **Department** R'Kiz

Region: Trarza

Location: Boubacar

Transect: Pastoral well North N° 7

Topography	Depression between dunes (goud)		
State of soil surface	Grey soil with sandy slabs		
I Ligneous	**Species**	**Height**	**Proportion %**
	1. Acacia raddiana 2. Balanites aegyptiaca 3. Acacia senegal	0.5 to 3m 0,5 to 4m 0,5 to 3m	70 20 10
Average range	2 to 20m		
II Herbaceous	Traces of mulch	**Percentage of overall coverage** <5%	
General state of grass. land	- 80% of dead gumtrees - Degraded grazing land - Dead gum trees create piles which cause the accumulation of sand and small moving dunes formation - Area of absolute degradation (bare soil) along 200 to 300 m		

Observation Date: 05/15/1980 **Department** Loutilimit

Region: Trarza -06

Location: N'Ghadage

Transect: Pastoral well - South West N° 8

Topography	Dunes and gouds alternation (depression between dunes) turned toward North-East-South-West		
State of soil surface	Sandy soil on dunes, sandy clay soil inside depressions		
I Ligneous	**Species**	**Height**	**Proportion %**
	1. Commiphora africana	2 to 3m	80
	2. Maerua crassifolia	0,5 to 1m	
	3. Acacia raddiana	2m	20
	4. Balanites aegyptiaca	2m	
Average range	20 m		
II Herbaceous	Leptadenia spartium: 0,5 m	**Percentage of overall coverage** < 5%	
General state of grass. land	- Degraded grazing land - 50% of Commiphora are dead - Appearance of moving sand - Area of absolute degradation (bare soil) along 200 to 300 m		

Observation Date: 06/20/1980 **Department** Kaykossa

Region: Assaba -03

Location: Gaouyere

Transect: Pastoral well-South-East & N° 16

Topography	Range of dunes overhanging East part of the oued Gaouyere		
State of soil surface	Sandy soil of fixed dune		
I Ligneous	Species	Height	Proportion %
	1. Combretum glutinosum 2. Calotropis procera 3. Sclerocarya birrea 4. Adansonia digitata 5. Hyphaene thebaica	2 to 6m 0,5 to 1m 2 to 6m 6m 1 to 8m	50% 50%
Average range	5 to 10 m		
II Herbaceous	None	Percentage of overall coverage	
General state of grass. land	- Rather small tree grazing land - Degraded grazing land (cutting for roof) - Concrete well, slightly pronounced area of degradation toward this direction		

Observation Date: 06/20/1980 **Department** Kankossa

Region: Assaba 03

Location: Gaouyere

Transect: Pastoral well- North East N° 16

Topography	Low sandy area		
State of soil surface	Sandy soil on the way to remobilization		
I Ligneous	**Species**	**Height**	**Proportion %**
	1.Combretum glutinosum 2. Calothropis procera 3. Sclerocarya birrea 4. Acacia senegal 5. Balanites aegyptiaca 6. Acacia raddiana 7. Adansonia digitata	4 to 6m 0,2 to 0,8m 3 to 6m 0,5 to 4m 0,5 to 3m 2m 6m	60
Average range	1 to 10 m		
II Herbaceous	None	**Percentage of overall coverage**	
General state of grass. land	- Excepted Combretum glutinosum, the grazing land is in good state - Concrete well, more pronounced area of degradation in comparison with the transect A.		

Observation Date: 06/21/1980 **Department** Barkeol.

Region: Assaba 03

Location: Griguel

Transect: Pastoral well-West B N° 21

Topography	West bank plain of Greiguel oued		
State of soil surface	Brown clayey soil		
I Lignaous	Species	Height	Proportion %
	1. Balanites aegyptiaca	0,5 to 5m	30
	2. Zizyphus mauritiana	0,5 to 5m	
	3. Boscia senegalensis	1 to 4m	
	4. Acacia senegal	3m	
	5. Acacia flava	0,5 to 2m	70
	6. Mytragina inermis	3m	
	7. Capparis decidua	3m	
	8. Acacia nilotica	2m	
	9. Acacia seyal	2m	
Average range	1 to 10 m		
II Herbaceous	None	Percentage of overall coverage	
General state of grass. land	- Besides drying (Zizyphus) there is a pruning for cattle and for fields fences - Area of degradation along about 200m around oglat		

Observation Date: 06/21/1980 **Department** Barkeol

Region: Assaba 03

Location: Greiguel

Transect: Pastoral well-South- East N° 21

Topography	The oued (Greiguel) bed- Relative flatness of the place (Aftout)		
State of soil surface	Compact clayey soil		
I Ligneous	Species	Height	Proportion %
	1. Balanites aegyptiaca	0,5 to 2m	30
	2. Acacia nilotica	0,5 to 2m	20
	3. Acacia flava	0,5 to 2m	
	4. Zizyphus mauritiana	0,5 to 3m	
	5. Capparis decidua	0,5 to 3m	
	6. Acacia senegal	2m	50
	7. Mytragina inermis	1 to 2m	
	8. Calothropis procera	1m	
	9. Tamarindus indica	6m	
	10. Bauhinia rufescens	3m	
Average range	1 to 8 m		
II Herbaceous	None	Percentage of overall coverage	
General state of grass. land	- Area of degradation around the oglat along about 200m - Shrubby area which is outside of area of degradation , is on the way to a good regeneration		

Observation Date: 05/17/1980 **Department** Mederdra

Region: Trarza 06

Location: Mederdra South

Transect: Pasture N° 5

Topography	Rather large depression between dunes (goud)		
State of soil surface	Fixed sandy soil(fairly sanded goud)		
I Ligneous	Species	Height	Proportion %
	1. Acacia senegal 2, Balanites aegyptiaca 3. Acacia raddiana 4. Maerua crassifolia 5. Zizyphus mauritiana	1 to 3m 0,5 to 5m 0,5 to 3m 1m 2m	60 20 — : 20 :
Average range	10 to 20 m and 50 m in places		
II Herbaceous	Mulch of Cenchrus biflorus	Percentage of overall coverage < 5%	
General state of grass. land	- 80% of Acacia senegal are dead - Many Balanites are dead - Considerable desertification, a lot of zeribas - Severely degraded pasture		

Observation Date: 05/16/1980 **Department** Boutilimit

Region: Trarza 06

Location: Between Boutilimit and Meederra

Transect: Pasture N° 6

Topography	More or less flat dunes		
State of soil surface	Sandy soil		
I Ligneous	Species	Height	Proportion %
	1. Balanites aegyptiaca 2. Acacia senegal	0,5 to 2m 0,5m	90 10
Average range	5 to over 20 m		
II Herbaceous	Panicum turgidum: 5 cm	Percentage of overall coverage $< 5\%$	
General state of grass, land	- The worst pasture of Trarza - Almost total dis apearance of Acacia senegal remains covered by sand Balanites are truncated in the middle		

Observation Date: 05/22/1980 **Department** Nederdra

Region: Trarza 06

Location: Between Boutilimit and Tiguent

Transect: Pasture N° 1

Topography	Sandy ground with small undulations-Leveled dunes		
State of soil surface	More or less fixed sandy soil		
I Ligneous	Species	Height	Proportion %
	1. Acacia senegal	3 to 5m	100
Average range	10 to 30 m		
II Herbaceous	Mulch of Cenchrus biflorus Panicum turgidum	Percentage of overall coverage < 5%	
General state of grass. land	- Area of rain fed land cultivation (beref , niebe) - Intensive reclaiming : zeribas, dead stumps - Insignificant pasture		

Observation Date: 05/23/1980 **Department** Rosso

Region: Trarza 06

Location: Between Nouakchott and Rosso

Transect: Pasture N° 4

Topography	Depressions between dunes		
State of soil surface	More or less heavy greyish clayey soil		
I Ligneous	Species	Height	Proportion %
	1. Acacia senegal	0,5 to 4m	40
	2. Acacia raddiana	0,5 to 5m	30
	3. Balanites aegyptiaca	0,2 to 6m	20
	4. Bauhinia rufescens	1 to 3m	
	5. Maerua crassifolia	1,5m	10
	6. Acacia seyal	2m	
Average range	1 to 5 m		
II Herbaceous	Mulch of Cenchrus biflorus	Percentage of overall coverage < 5%	
General state of grass. land	- 25% of gum trees are dead - Former and recent pruning - Wandering animals - In spite of pruning this pasture is in places in good state		

Observation Date: 05/15/1980 **Department** Boutilimit

Region: Trarza 06

Location: Between Nouakchott and Boutilimit

Transect: Pasture N° 9

Topography	System of Trarza dunes: dunes/gouds		
State of soil surface	Sandy		
I Ligneous	Species	Height	Proportion %
	1. Commiphora africana 2. Acacia raddiana 3. Balanites aegyptiaca 4. Capparis decidua	3m 2 to 4m 2m 3 to 5m	60 40
Average range	less than 1 m to 30 m		
II Herbaceous	None	Percentage of overall coverage	
General state of grass. land	- 80% of Commiphora are dead - Bad state of pastures on dunes - Better pasture in low grounds (groves)		

Observation Date: 06/11/1980 **Department** Moudjeria

Region: Tagant - 09

Location: Alatfatar

Transect: Pasture N° 10

Topography	The Aftout rag - Flat and gully surface		
State of soil surface	Clayey and slightly pebbly soil		
I Ligneous	Species	Height	Proportion %
	1. Capparis decidua 2. Balanites aegyptiaca 3. Acacia raddiana 4. Zizyphus mauritiana 5. Acacia flava 6. Maerua crassifolia	0,5 to 3m 1 to 3m 0,5 to 3m 2 to 4m 0,5 to 3m 0,5m	70 — : : 30 : :
Average range	2 to 15 m		
II Herbaceous	None	Percentage of overall coverage	
General state of grass. land	- Aerial pasture in good state but many Balanites aegyptiaca and Capparis decidua are pruned for cattle - Very clear pasture with large bare beaches		

Observation Date : 06/12/1980 Department : Moudjeria

Region : Tagant - 09

Location : Between Moudjeria and M'Beika

Transect : Pasture N° 11

Topography	Oued Slightly gashed into Tagant plateau		
State of Soil Surface	Sandy soil on the Oued borders and sandy-silty soil in the bed. Rocks (sandstones) in vicinity		
I Ligneous	Species	Height	Proportion %
	1. Euphoria balsamifera 2. Boscia senegalensis 3. Maerma crassifolia 4. Balamites aegyptiaca 5. Acacia senegal 6. Capparis decidua	0,5-3 m 0,5-3 m 1 -4 m 0,2-3 m 0,5 m 0,2-0,5m	80 % 20 %
Average range	In the Oued bed : 1 to 10 m On the slopes of the Oued : 10 to 50 m		
II Herbaceous	Mulch on the soil Leptademia spartium: 0,2 to 1 m Panicum turgidum : 0,2 to 0,8 m Young shoots due to the rain of June 1980; less 1 cm	Percentage of overall coverage : ± 20 %	
General state of grass. land	Pasture in relatively good state - Dead Comnaiphone africana standing up Dry euphorbia		

Observation Date: 06/15/1980 **Department** Rachid

Region: Tagant 09

Location: Between Aghlambit and Nimelane

Transect: Pasture N° 12

Topography	Alternation of small low grounds and dunes fixed on the Tagant plateau		
State of soil surface	Clayey soil with sandy overlappings, substrat: Tagant sandstone		
I Ligneous	**Species**	**Height**	**Proportion %**
	1. Euphorbia balsamifera	0,5 to 2m	70
	2. Balanites aegyptiaca	0,5 to 3m	10
	3. Commiphora africana	1 to 3m	—
	4. Maerua crassifolia	0,5 to 3m	:
	5. Boscia senegalensis	1 to 3m	:
	6. Acacia raddiana	2 to 5m	: 20
	7. Acacia senegal	2m	:
	8. Zizyphus mauritiana	1,5m	:
	9. Salvadoria persica	2m	:
Average range	1 to 5 m		
II Herbaceous	-Leptadenia spartium: 0,5 to 1m - Panicum turgidum: 0,5m	**Percentage of overall coverage** <5%	
General state of grass. land	- This area is a victim of growing silting up - 90% of Commiphora are dead		

Observation Date: 06/18/1980 **Department** Boumdeid

Region: Assaba 03

Location: Between Ghoudia and Boumdeid

Transect: Pasture N° 13

Topography	Flat ground cut with small oueds		
State of soil surface	Clayey soil with a presence of sandy slabs and rocky outcrops in places (sandstone of Tagant)		
I Ligneous	Species	Height	Proportion %
	1. Euphorbia balsamifera	0,5 to 4m	50
	2. Boscia senegalensis	0,5 to 3m	
	3. Acacia flava	0,5 to 3m	:
	4. Commiphora africana	1 to 4m	:
	5. Acacia flava	1 to 5m	: 50
	6. Acacia raddiana	0,5 to 2m	:
	7. Calothropis procera	1 to 3m	:
	8. Balanites aegyptiaca	1 to 3m	:
	9. Capparis decidua	2 to 3m	:
Average range	5 to 10 m		
II Herbaceous	- Panicum turgidum: 0,1 to o,5m - Young grass shots; - Non identified graminae	Percentage of overall coverage < 5%	
General state of grass. land	- Pasture touched by drought (Commiphora) and on the way to di.sapearance		

Observation Date: 06/18/1980 **Department** Boumdeid

Region: Assaba - 03

Location: Between Boumdeid and Kiffa

Transect: Pasture N° 14

Topography	Alternation of dunes and interdunes		
State of soil surface	More or less compact clayey soil in the interdunes and fixed sandy soil on the dunes		
I Ligneous	Species	Height	Proportion %
	1. Acacia senegal	0,5 to 3m	30
	2. Balanites aegyptiaca	0,5 to 6m	10
	3. Acacia flava	1 to 3m	
	4. Maerua crassifolia	1 to 6m	:
	5. Capparis decidua	3m	: 60
	6. Acacia raddiana	0,5 to 4m	:
Average range	5 to 20 m		
II Herbaceous	Leptadenia spartium: 0,5 to 1m, Panicum turgidum: 0,5 to 0,8cm	Percentage of overall coverage <5%	
General state of grass. land	- Shrubby pasture with some big alone trees - Many gum trees have been decimated since the beginning of the drought		

Observation Date: 07/10/1980 **Department** Kiffa

Region: Assaba 03

Location: South of Amredjel

Transect: Pasture N° 15

Topography	The oued Amredjel bed - Fairly flat region		
State of soil surface	Brown clayey - silty soil		
I Ligneous	Species	Height	Proportion %
	1. Acacia raddiane	0,5-8 m	40 %
	2. Balanites aegypticae	0,5-6 m	20 %
	3. Acacia flare	2 -5 m	20 %
	4. Zizyphus mauritiana	2 -5 m	10 %
	5. Acacia nilotica	8 m	10 %
	6. Bauhima rufescens	3 -4 m	
	7. Capparis decidua	1 m	
Average range	1 to 5 m		
II Herbaceous	None	Percentage of overall coverage	
General state of grass. land	- Considerable tree pasture - A lot of reclaiming : cattle and zeribas - Wandering animals - Dried accacia flare : 10 % - Dead acacia reddiane : 10 %		

Observation Date: 06/18/1980 **Department** Selibaby

Region: Guidimakha 10

Location: Between Gouraye and Selibaby

Transect: Pasture N° 17

Topography	Plain dotted with hills		
State of soil surface	Sandy		
I Ligneous	Species	Height	Proportion %
	1. Acacia senegal	1 - 3 m	40 %
	2. Balanites aegyptiace	1 - 3 m	20 %
	3. Combretum glutinosum	1 - 5 m	10 %
	4. Acacia seyal	1 - 6 m	30 %
	5. Acacia nilotica	4 m	
	6. Sclerocarya birrea	4 m	
Average range	1 to 10 m		
II Herbaceous	Andropogon	Percentage of overall coverage ± 10 %	
General state of grass. land	Pasture in fairly good state, relatively dense (with trees)		

Observation Date: 06/19/1980 **Department** Selibaby

Region: Guidimakha 10

Location: Between Selibaby and Harr

Transect: Pasture N° 18

Topography	Vast depression-Several kilometers large plain		
State of soil surface	Sandy-clayey soil		
I Ligneous	Species	Height	Proportion %
	1. Acacia senegal 2. Acacia seyal 3. Balanites aegyptiace 4. Adansonia digitata	0,5-5 m 0,5-3 m 1 -4 m 4 m	40 % 20 % 40 %
Average range	5 to 15 m		
II Herbaceous	Although dry fairly large grass carpet	Percentage of overall coverage ± 10 %	
General state of grass. land	Slightly degraded grazing land		

Observation Date: 06/19/1980 **Department** Maghama

Region: Guidimakha 10

Location: Between Harz and Maghama

Transect: Pasture N° 19

Topography	Plain		
State of soil surface	Sandy		
I Ligneous	Species	Height	Proportion %
	1. Combretum Glutinosum 2. Sclérorya birrea	2 - 5 m 5 m	90 % 10 %
Average range	5 to 15 m		
II Herbaceous	Andropogon (dry mulch)	Percentage of overall coverage < 5 %	
General state of grass. land	Slightly degraded pasture		

Observation Date: 06/15/1980 **Department**

Region: Gorgol - 04

Location: Between Soufa and the pass

Transect: Pasture N° 20

Topography	Undulating relief of Assaba West border (sandstone landscape)		
State of soil surface	Gullies cut into a sandy material with ferruginous gravels - Sandstone blocs (rocky substrat : Assaba sandstone)		
I Ligneous	Species	Height	Proportion %
	1. Combretum glutinosum	1 - 5 m	60 %
	2. Zizyphus mauritiana	0,5- 2 m	10 %
	3. Acacia flava	0,5- 2 m	30 %
	4. Acacia senegal	1 - 4 m	
	5. Acacia seyal	1 - 5 m	
	6. Adansonia digitata	5 m	
	7. Commiphone africana	4 - 5 m	
	8. Sterculia setigere	3 - 4 m	
Average range	2 to 30 m		
II Herbaceous	none	Percentage of overall coverage	
General state of grass. land	Fairly dense aerial pasture with vast scattered clearings No visible wandering animals (no water points)		

Observation Date: 07/19/1980 **Department** Tintane

Region: Hodh el Chargui - 02

Location: Between Touil and Ain Fabre

Transect: Pasture N° 22

Topography	Plain		
State of soil surface	Clayey soil covered with sandy slabs		
I Ligneous	Species	Height	Proportion %
	1. Combretum glutinosum	0,5 - 5 m	60 %
	2. Adansonia digitata	6 m	20 %
	3. Sterculia tomentosa	6 m	10 %
	4. Sterocerya birrea	6 m	
	5. Guiere senegalensis	1 - 2 m	
	6. Ondoun lafness	3 m	
	7. Lahouedgna	2 - 4 m	10 %
	8. Balamites aegyptiace	3 m	
Average range	5 to 10 m		
II Herbaceous	Non identified species	Percentage of overall coverage 20-30 %	
General state of grass. land	Very dense grass carpet : 5 to 10 cm Wandering Animals Grass and tree pasture in good state		

Observation Date: 07/13/1980 **Department** Aioun el Atrouss

Region: Hodh el Chargui - 02

Location: Oum lahbal

Transect: Pasture N° 23

Topography	Plain with low grounds		
State of soil surface	Sandy soil onto plain Clayey soil in low grounds		
I Ligneous	Species	Height	Proportion %
	1. Acacia senegal	0,5 - 3m	50 %
	2. Acacia raddiana	0,5 - 4m	30 %
	3. Balamites aegyptiace	0,5 - 3m	20 %
	4. Acacia flave	0,5 - 3m	
	5. Acacia seyal	1 - 3m	
	6. Calothropis procena	0,5 - 3m	
Average range	1 to 5 m		
II Herbaceous	Very scatterd mulch	Percentage of overall coverage < 5 %	
General state of grass. land	- In spite of severe reclaiming of Acacia raddiane, Acacia seyal, Acacia senegal and Balamites aegyptiaca this pasture is in good condition - Wandering animals		

Observation Date: 07/17/1980 **Department** Djigueni

Region: Hodh el Chargui - 01

Location: Between Bousteila and Djigueni

Transect: Pasture N° 24

Topography	Plain		
State of soil surface	Calyey soil covered with sandy fixed slabs		
I Ligneous	Species	Height	Proportion %
	1. Combretum	0,5 - 6m	70 %
	2. Sclerocarya birrea	6 m	30 %
	3. Balamites aegyptiaca	1 m	
	4. Acacia senegal	1 m	
	5. Combretum aculeatum	1 - 1,5m	
	6. Sterculia tomentosa	6 m	
Average range	5 to 20 m		
II Herbaceous	none	Percentage of overall coverage	
General state of grass. land	- 30 % of Combretum are dried - Intensive cutting of Sclerocarya birrea and Stericulia tomentosa. Camp of nomads - Degraded pasture		

Observation Date: 07/14/1980 **Department** Nema

Region: Hodh el Chargui - 01

Location: Between Oualata and Nema

Transect: Pasture N° 25

Topography	Gully and flat surface - Aftout type		
State of soil surface	Sandy, clayey soil in alternation with cobby grounds		
I Ligneous	Species	Height	Proportion %
	1. Acacia flava	1 - 3m	30 %
	2. Acacia Seyal	1 - 3m	20 %
	3. Balamites aegyptiaca	0,5 - 5m	50 %
	4. Commiplone africana	1 - 5m	
	5. Maerua crassifolia	1 - 6m	
	6. Boscia senegalensis	1 - 2m	
	7. Salvadonia persica	2 - 6m	
	8. Zizyphus mauritiana	1 - 6m	
	9. Combretum aculeatum	1 m	
Average range	1 to 5 m		
II Herbaceous	Panicum turgidum : 0,2 to 0,5 m	Percentage of overall coverage	<5 %
General state of grass. land	- Acacia flave dried standing up - Former pruning - Aerial pastures in fairly good state		

Observation Date: 05/30/1980 **Department** Rosso

Region: Trarza - 06

Location: Tine Bunaz

Transect: Classified Forest N° 1

Topography	Flat ground		
State of soil surface	Clayey sandy packed down soil		
I Ligneous	Species	Height	Proportion %
	1. Gymnosporia senegalensis	0,5-3 m	80 %
	2. Acacia seyal	0,5-2 m	
	3. Borassus flabelhifer	0,5-1 m	
	4. Balanites aegyptiaca	1 -4 m	
	5. Acacia senegal	2 -6 m	20 %
	6. Acacia albida	5 -6 m	
	7. Zizyphus mauritiana	0,5-1,5m	
	8. Salvadoria persica	3 -4 m	
	9. Indigofera	0,5-1 m	
	10. Bauhinia rufescens	2,5 m	
Average range	5 to 10 m		
II Herbaceous	A little andropogon mulch	Percentage of overall coverage < 50 %	
General state of grass. land	- Bad general state - Many dried trees - Pruning - Wandering animals - No coal oven		

Observation Date: 05/30/1980 **Department** Rosso

Region: Trarza - 06

Location: Tounguen

Transect: Reafforestation perimeter N° 2

Topography	Flat ground		
State of soil surface	Packed down soil (glazing) and clayey on the surface		
I Ligneous	Species	Height	Proportion %
	1. Tamaris senegalensis	0,5-1 m	80 %
	2. Balamites aegyptiaca	0,5-5 m	20 %
	3. Prosopis	3 -4 m	
	4. Acacia seyal	0,5-2 m	
	5. Acacia albida	1 -3 m	
Average range	5 to 15 m		
II Herbaceous	Non identified	Percentage of overall coverage	< 5 %
General state of grass, land	The reafforestation perimeter seems like a vasteland The soil is trampled on and there is a lot of pruning Bad general state. Numerous gonakies dead stumps reveal the existence of an ancient forest.		

Observation Date: 05/22/1980 **Department** Mederdra

Region: Trarza - 06

Location: Boutiliss

Transect: Classified Forest N° 3

Topography	More or less flat sandy ground		
State of soil surface	More or less fixed sandy soil		
I Ligneous	Species	Height	Proportion %
	1. Acacia senegal 2. Acacia raddiana 3. Balamites aegytiaca 4. Maerua crassifolia	0,5-5 m 0,5-2 m 0,5-5 m 1 m	50 % 30 % 15 % 5 %
Average range	2 to 10 m		
II Herbaceous	- Panicum turgidum - Leptadenia spartium - Poor mulch of Cenchrus biflorus	Percentage of overall coverage < 5 %	
General state of grass. land	- 90 % of gumtrees are dead - 95 % of Acacia raddiana are dead as well as 80.% of Balamites - Small shoots are devastated by animals, the big ones are victimes of cutting and pruning - Mediocre state		

Observation Date: 05/22/1980 **Department** Mederdra

Region: Trarza - 06

Location: Tin Yera

Transect: Classified Forest N° 4

Topography	Flat sandy ground		
State of soil surface	Fixed sandy soil		
I Ligneous	Species	Height	Proportion %
	1. Balamites aegyptiaca	0,1-6 m	50 %
	2. Acacia raddiana	0,2-3 m	20 %
	3. Acacia senegal	0,2-8 m	30 %
	4. Calothropis procene	0,1-1,5m	
	5. Maerna crassifolia	1 m	
	6. Zizyphus mauritiana	2 m	
Average range	2 to 10 m		
II Herbaceous	- Cenchrus biflorus mulch - Leptadenia spartium	Percentage of overall coverage	< 5 %
General state of grass. land	- 50 % of gum tress are dead, some dead Balamites - Small tress (0,5 to 1 m). A lot of cutting and pruning. Partial reclaimings. Degraded forest.		

Observation Date: 05/23/1980 **Department** Hederdra

Region: Trarza - 06

Location: Hmar el ha

Transect: Classified Forest N° 5

Topography	More or less flat sandy ground		
State of soil surface	Fixed sandy soil		
I Ligneous	Species	Height	Proportion %
	1. Acacia senegal 2. Balamites aegyptiaca 3. Acacia raddiana	0,5 - 5m 0,8 - 8m 0,5 - 4m	50 % 30 % 20 %
Average range	3 to 10 m		
II Herbaceous	Centrus biflorus (mulch)	Percentage of overall coverage	< 5 %
General state of grass. land	- 40 % of gum tress are dead - An important regeneration of 3 species mentioned above (0,5 to 2 m) - frequent pruning and cutting - Wandering animals - In spite of cutting and wandering animals there is an important regeneration actually.		

Observation Date : 05/31/1980 Department : Rosso

Region : Trarza - 06

Location : Keur Mour (Dagana)

Transect : Classified forest N° 6

Topography	Flat relief - Senegal River border		
State of soil surface	Clayey-sandy soil		
I Ligneous	Species	Height	Proportion %
	1. Acacia nilotica 2. Borassus flabellifer 3. Salvadoria persica 4. Tamarix senegalensis	12 m 10 m 3 - 6 m 1 - 2,5m	90 % 10 %
Average range	5 to 15 m		
II Herbaceous	Rather dense vegetable carpet alongside river but there is a lot of clearings there; the herbaceous are virtually in-existant	Percentage of overall coverage + - 5 %	
General state of grass land	Degradation state is fairly advanced. There is everywhere the traces of cutting and reclaiming. The charcoal is made up inside the classified forest; actually, a great number of charcoal ovens.		

Observation Date: 05/31/1980 **Department** Rosso

Region: Trarza - 06

Location: Gani

Transect: Classified Forest N° 7

Topography	Flat relief - Senegal River south border		
State of soil surface	Sandy, clayey soil		
I Ligneous	Species	Height	Proportion %
	1. Acacia nilotica	5 - 6 m	100 %
Average range	5 to 15 m		
II Herbaceous	No herbaceous	Percentage of overall coverage	
General state of grass. land	- Numerous dried trees - Dead branches on the ground - A lot of charcoal ovens - Exploitation of Acacia nilotica pods - Advanced degradation		

Observation Date: 06/02/1980 **Department** Boghé

Region: Brakna - 05

Location: Tessem

Transect: Classified Forest N° 8

Topography	Flat relief		
State of soil surface	Sandy clayey soil		
I Ligneous	Species	Height	Proportion %
	1. Acacia nilotica	4 - 7 m	100 %
Average range	5 - 20 m		
II Herbaceous	none	Percentage of overall coverage	
General state of grass. land	- Bad general state - No grass carpet - Exploitation of Acacia nilotica pods - Wandering animals - A lot of pruning - No charcoal oven noticed		

Observation Date: 06/02/1980 **Department** Boghé

Region: Brakna - 05

Location: L'Boyo

Transect: Classified Forest N° 9

Topography	Flat ground		
State of soil surface	Clayey sandy soil		
I Ligneous	Species	Height	Proportion %
	1. Acacia nilotica 2. Balamites aegyptiaca 3. Salvadoria persica 4. Acacia seyal	8 m 1 - 3 m 2 - 4 m 1 - 3 m	60 % 40 %
Average range	5 to 15 m		
II Herbaceous	none	Percentage of overall coverage	
General state of grass. land	- Widespread dryness - No herbaceous cover - Very advanced degradation - One can notice the Acacia nilotica regeneration (0,5 to 3 m) into the small depressions flooded by rain water. Actual charcoal ovens in a vicinity of classified forest however outside of it.		

Observation Date: 06/02/1980 **Department** Boghé

Region: Brakna - 05

Location: Dar el Barka

Transect: Classified Forest N° 10

Topography	Flat relief		
State of soil surface	Sandy clayey soil trampled on		
I Ligneous	Species	Height	Proportion %
	1. Acacia nilotica 2. Balamites aegyptiaca 3. Cadaba farinosa 4. Salix senegalensis 5. "Degueur" (poular)	15-20 m 2- 4 m 10 m 5 m 3- 4 m	80 % 20 %
Average range	5 to 20 m		
II Herbaceous		Percentage of overall coverage	
General state of grass. land	Important dryness. Intensive pruning. Wandering animals. Live trees are in precarious state. Important widespread degradation. A small grass cover on the low grounds (Ouro Gandé). No charcoal ovens in the classified forest.		

Observation Date: 06/02/1980 **Department** Boghé

Region: Brakna - 05

Location: Olo-Ologo

Transect: Classified forest N° 11

Topography	Flat ground		
State of soil surface	Clayey sandy soil		
I Ligneous	Species	Height	Proportion %
	1. Balamites aegyptiaca 2. Acacia nilotica 3. Capparis decidua 4. Boscia senegalensis	1 - 3 m 1 -2,5m 0,5-2 m 1 - 2 m	80 % - 20 %
Average range	5 to 30 m		
II Herbaceous	None	Percentage of overall coverage	
General state of grass. land	Severely cut Balamites aegyptiaca as well as Capparis decidua. Wandering animals. Very thined forest No charcoal ovens noticed. No a lot of dryness Small number of gonakiers.		

Observation Date: 06/02/1980 **Department** Boghé

Region: Brakna - 05

Location: Silbe

Transect: Classified Forest N° 12

Topography	Flat ground		
State of soil surface	Sandy, clayey soil		
I Ligneous	Species	Height	Proportion %
	1. Acacia bnilotica 2. Bauhinia rufescens 3. Boscia senegalensis 4. Bauhimia reticulata 5. Capparis decidua	10 m 2 - 4 m 1 - 2 m 3 - 4 m 1 - 3 m	80 % 20 %
Average range	5 to 20 m		
II Herbaceous	none	Percentage of overall coverage	
General state of grass. land	Bad general state. Big charcoal ovens inside the forest. Over 50 % of gonekiers are dead. Trees attained by termites are weakening. Live trees are incinerated near soil.		

Observation Date: 06/03/1980 **Department** Boghé

Region: Brakna - 05

Location: Lopel

Transect: Classified forest N° 13

Topography	Flat ground		
State of soil surface	Sandy clayey soil		
I Ligneous	Species	Height	Proportion %
	1. Acacia nilotica 2. Zizyphus mauritiana 3. Indigofera 4. Balamites aegyptiaca 5. Acacia albida 6. Bauhinia rufescens	10 m 1 - 3 m 1 - 2 m 0,5-4 m 1 - 3 m 1 - 4 m	80 % 20 %
Average range	2 to 15 m		
II Herbaceous	None	Percentage of overall coverage	
General state of grass. land	Livestock stempting. Intensive pruning. No regeneration. No charcoal ovens noticed.		

Observation Date: 06/03/1980 **Department** Boghé

Region: Brakna - 05

Location: Ganki

Transect: Classified Forest N° 14

Topography	Flat ground		
State of soil surface	Sandy clayey soil		
I Ligneous	Species	Height	Proportion %
	1. Acacia nilotica 2. Acacia seyal 3. Indigofera	of 10 m 0,5 -3m 0,5 -2m	60 % 40 %
Average range	5 to 20 m		
II Herbaceous	A kind of heather on the ground (in poular - nipere)	Percentage of overall coverage < 5 %	
General state of grass. land	- Wild pruning. Numerous cut and burnt stumps. - Wandering animals. numerous bare beaches. - Severely crippled acacia nilotica. No charcoal ovens noticed.		

Observation Date: 06/03/1980 **Department** Boghé

Region: Brakna - 05

Location: Oualalde

Transect: Classified Forest N° 15

Topography	Flat ground along Senegal River		
State of soil surface	Sandy soil		
I Ligneous	**Species**	**Height**	**Proportion %**
	1. Acacia nilotica	of 10 m	80 %
	2. Balamites aegyptiaca	0,5-. 3 m	2o %
	3. Bauhinia rufescens	1 - 2 m	
	4. Acacia seyal	0,5-1,5m	
	5. Capparis decidua	0,5- 3 m	
	6. Salix senegalensis	of 4m	
Average range	2 to 10 m		
II Herbaceous	None	**Percentage of overall coverage**	
General state of grass. land	- Bad general sta... Intensive pruning. - Wandering animals. A lot of dead trees. - A lot of termitary. - No charcoal ovens noticed.		

Observation Date: 04/19/1980 **Department** Maghama

Region: Gorgol - 04

Location: N'Gouye

Transect: Classified forest N° 16

Topography	Raised bank of Senegal river zith a depression in walo.		
State of soil surface	Brown compact soil (soil catted walo)		
I Ligneous	Species	Height	Proportion %
	1. Bauhinia reticulata	0,5 - 3m	50 %
	2. Acacia nilotica	0,5 - 6m	40 %
	3. Bauhinia rufescens	0,5 - 2m	20 %
	4. Balamites aegyptiaca	0,5 - 4m	
Average range	1 m to 5 - 10 m		
II Herbaceous	None	Percentage of overall coverage	
General state of grass, land	Fairly bad state : dryness, especially, dryness of gonakiers, on the other hand, there is an impressive regeneration of gonakiers on the north west forest border; a great number of young shoots break out. - Numerous termites. Fire traces, no charcoal ovens reported, Gonakiers live particularly in the lowest parts.		

Observation Date: 06/10/1980 **Department** Kirfa

Region: Assaba - 03

Location: Nehame

Transect: Classified forest N° 17

Topography	Flat ground		
State of soil surface	Fixed clayey sandy soil		
I Ligneous	**Species**	**Height**	**Proportion %**
	1. Acacia senegal	0,5 - 1m	80 %
	2. Balamites aegyptiaca	0,5 -	15 %
	3. Combretum gluti	2 - 4 m	.5 %
	4. Capparis decidua	0,5 - 3m	
	5. Calothropis procera	1 m	
Average range	10 to 15 m		
II Herbaceous	None	**Percentage of overall coverage**	
General state of grass. land	- 60 % of gum trees are dead and knocked down - 30 % of Balamites are dead. The classified forest is victim of dryness and cutting. - An important regeneration of gum trees and Balamites is on the way.		

Annexe III

Appendice III

Questionnaire Utilisé sur le Terrain

Questionnaire Used in the Field

Utilized Questionnaire

Observation Date:

Name:

Region - Department

I Water

1. Number of wells
2. Kind of well (oglata, concrete)
3. State of well (sanded up, crushed etc.)
4. Depth
5. Water quality (soft, briny)
6. Salinisation tendency
7. Water level variation during a year
8. Are the wells used for men and animals at the same time or separately ?
9. Are the wells sufficient for watering population and animals?
10. How is the water drawn?
11. Other water points (specify)
12. Sanitary state of wells (limpid water, unclear water)
13. Other eventual observation

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II Physical constraint

14. The site geographic description
15. Soil description
16. Approximate dimensions of town
17. Is there any moving dunes ?
18. Situation in relation to town
19. Dothey threaten towns ?
20. Precise the major directions of dunes moving
21. Have the dunes been fixed in the past ?
22. Are the sandstorms more frequent since the drought ?
23. Which is the worst year in relation to the rain insuffiency ?
24. Which was the best year since the beginning of the drought ?
25. Are the sandy slabs more frequent ?
26. Water erosion in village and vicinity ?
27. Other observation

III Livestock

28. Cattle categories
29. Sedentary cattle

30. Distances traveled by animals according to their categories

31. Movement directions

32. Is there any cattle market ?

IV Animals and Pastures

33. Trees, bush and other things consummed by animals

34. Consummed species by different category of cattle

35. The most consummed species

36. Branches cutting for cattle feeding

37. Categories of cattle which suffer the most because of the drought and pasture degradation

V Wood exploitation

38. Cut species

39. Why they are cut ?

40. Is the product of cutting sold or not ?

41. Are the gum trees pruned ?

42. Is the arabic gum gathered ?

43. Is the reason of vegetable cutting the insufficiency of pastures ?

VI Vegetation and Drought

44. Have the certain vegetable species disappeared since the drought ?
45. Have the certain species appeared since the drought ?
46. Is there any trees uprooted by wind ?
47. Other remarks

VII Crops

48. Used crops, location in relation to villag
49. Crops state
50. In case of some crops lack, have they existed in the past ?
51. Agricultural projects
52. Reafforestation projects

VIII Towns and populations

53. Proportion of population categories'
54. Sedentarization of nomads and other people
55. Fundation date of towns
56. Local tribes
57. Number of inhabitants - permanent - temporary