National Livestock Project Unit
Kaduna
Nigeria

LIVESTOCK, LAND USE AND HUMAN HABITATION IN THREE NIGERIAN GRAZING RESERVES SORAU, GARKIDA AND WAWA ZANGI.

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1. SUMMARY.

At the request of the Nigerian Livestock Project Unit (NLPU), Resource Inventory and Management Limited (RIM) carried out systematic low altitude aerial surveys of three recently established Grazing Reserves in Gongola and Bauchi States during the wet season of 1983 and the dry season of 1984. The primary objectives of the surveys were to establish tthe numbers and distribution of the livestock and human populations in and around the reserved areas, and to map the observed patterns of selected environmental parameters.

Of the three Reserves, two - Sorau and Garkida - are in northern Gongola State, the former close to the Cameroun border, and the latter near to the Hawal River. The third - Wawa Zangi - is in Bauchi State, to the south and east of the Gongola River.

All three regions are covered in predominantly woodland savannah, Wawa Zangi being the most heavily wooded. Sorau contains some hilly terrain, while the other two are mostly flat. Light cultivation (5 - 10%) was found in all three zones which, as expected, was often associated with the road network.

Surface water was widely available in Sorau and Garkida during the wet season, but was relatively sparse in Wawa Zangi. This was not the case in the dry season however, when, despite the provision of dams, sources of open water were very few and far between. Again, this was particularly true of Wawa Zangi.

The estimated numbers of cattle in all the survey zones were relatively low in comparison to those found in southern Gongola State, and the densities inside the Reserves were generally lower than those in surrounding regions. In all cases, cattle densities fell markedly between the wet and dry season surveys.

Sheep, on the other hand were comparatively numerous, and in contrast to those of the cattle, their populations were largest during the dry season. Like cattle, however their densities were generally greatest outside the Reserves themselves.

Arable dwellings were relatively sparse in the Garkida and Wawa Zangi regions, but not in Sorau. In Garkida, they were not less common within the Reserve boundaries, as they were in the other two areas. Agropastoralist dwellings were generally rare in Sorau and Garkida, but comparatively common in the south of Wawa Zangi.

In line with the cattle population, the habitation ascribed to both "settled" and "nomadic" pastoralists was widely dispersed, and their numbers fell between wet and dry seasons. There is some evidence that Sorau, but not Garkida or Wawa Zangi, supported a year round population of "settled" pastoralists inside the Reserve.

2. INTRODUCTION.

The relocation of the Nigerian national cattle herd in more southerly latitudes, and the sedentarization of pastoralists are two of the stated long term aims of Federal Government policy (David-West,1981). Towards this end, one of the priorities of Nigerian livestock development agencies has been the establishment of Grazing Reserves designed to provide year-round grazing and protection from the current expansion of arable farming.

Many of the longer established Grazing Reserves in Nigeria have indeed been subject to encroachment by cultivation, and/or suffered from land degradation due to overstocking and inappropriate management. In marked contrast, others have remained under-utilised. With such variation in Reserve development, it is clear that much must depend on the particular circumstances and prevailing conditions.

For current management and future planning it is obviously important to have objective and up to date assessments of the distribution and abundance of livestock populations, human habitation and cultivation both in and around existing or proposed Grazing Reserves. With the rapid changes taking place in the Nigerian environment, the expansion of agriculture and the increase in human population (Bourn, 1982), much of the information available to Reserve managers and project planners is old and unreliable. However, much of the necessary information can be obtained rapidly and conveniently from the air, and can be collected repeatedly in order to monitor and evaluate seasonal and long term changes in numbers and distribution patterns.

In the course of a detailed livestock and land use survey of southern Gongola State during July 1983, Resource Inventory and Management Limited (RIM) was requested by the National Livestock Project Unit (NLPU) to carry out aerial surveys of three recently established Grazing Reserves further to the north.

The primary objectives of these surveys were to:

1. Quantify and map the distribution of livestock populations;

2. Quantify and map the distribution of arable and pastoral habitations;

3. Map the distribution of selected environmental parameters;

4. Identify any seasonal changes in the observed parameters.

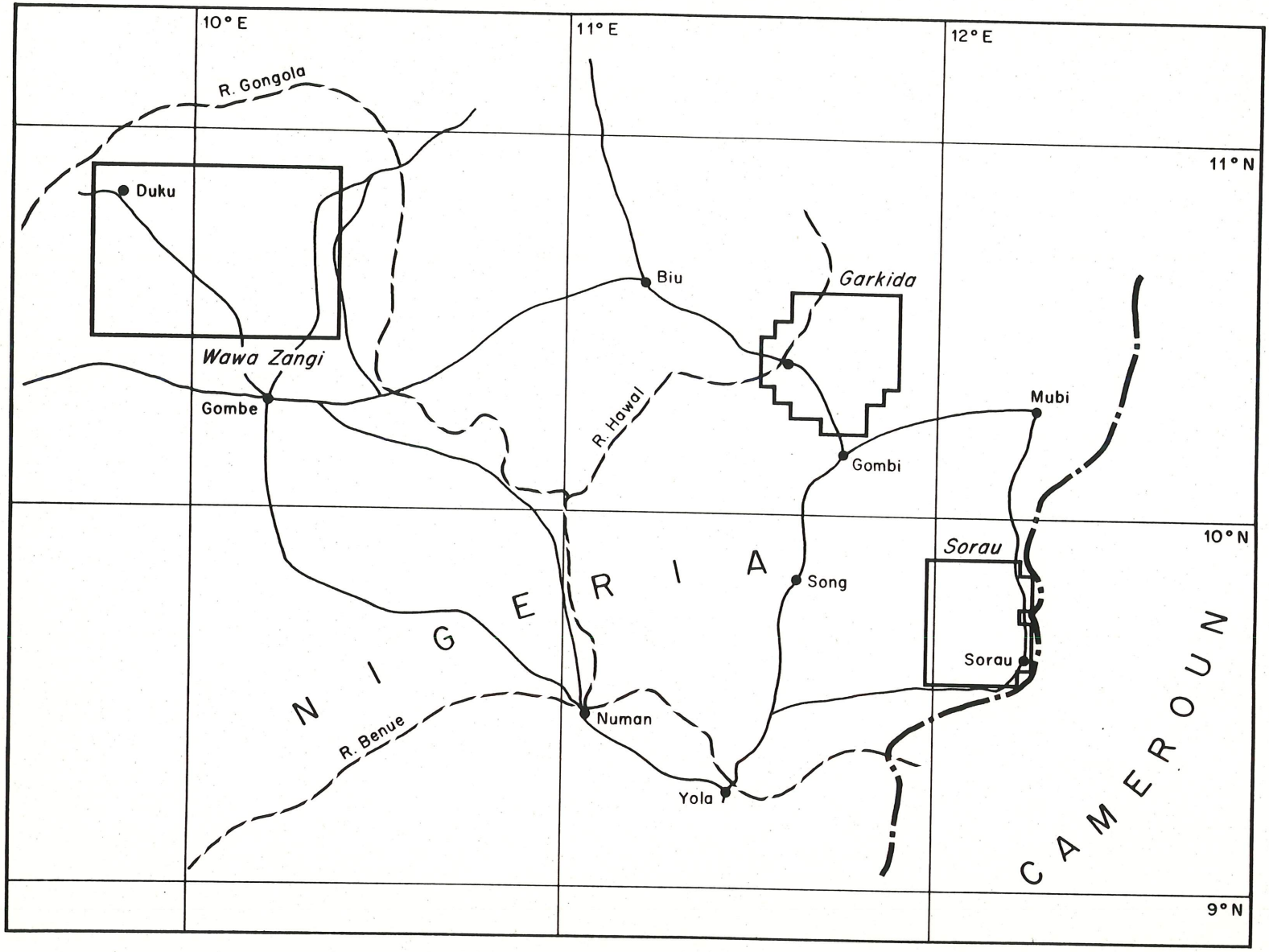
Wet and dry season surveys of the three Grazing Reserves - Sorau, Garkida and Wawa Zangi - were carried out at during the wet season of 1983, and the dry season of 1984. Sorau and Garkida Grazing Reserves are in northern Gongola State, the former close to the Cameroun border, and the latter close to the Hawal river. Wawa Zangi Grazing Reserve lies in the southeast of Bauchi State (Map 1). For each study area, the zone surveyed consisted of the Grazing Reserve itself and a surrounding band of five to ten kilometers, so that the distribution and abundance of the various parameters within the actual reserves could be viewed in their immediate context.

3. METHODS.

The aerial survey technique followed standard procedures for livestock and land use assessment described in RIM (1984). Conceptually, the survey zones were each divided into a regular 5 x 5 kilometer UTM sampling grid, which formed the basis for a systematic pattern of low level aerial sampling by a team of experienced observers, flying in a light aircraft along the centre line of each cell.

This systematic and unstratified sampling strategy was considered more valuable than a random stratified design for two major

Map 1. Location of Survey Zones



reasons. Firstly, each part of the survey areas was covered uniformly, so that the data collected was immediately mappable and relatively easy to interpret. Secondly, after the surveys, the information could be analysed in relation to a range of strata such as vegetation density, reserved or unreserved status, and so on. Such flexibilty of analysis and interpretation would be greatly reduced if the sample design had been locked into a specific and predetermined type of stratification. A further advantage of this sampling pattern was that it allowed the calculation of indeces based on the combination of several of the parameters measured for each grid square.

The four man survey team consisted of the pilot; two observers seated behind the pilot, each responsible for recording livestock and human habitation seen to the left and right of the aircraft; and a front seat observer who navigated and recorded land use, vegetation and selected environmental conditions (Table 1.).

The ground area sampled was restricted to two strips, one on each side of the aircraft, and demarcated by externally mounted adjustable viewing frames. The total ground strip width, when flying at 700 feet above ground level, was 710 meters during the wet season, and 515 meters during the dry season survey. Any deviations from the desired height were recorded, and the data corrected accordingly. The overall sampling intensity was 14.2% and 10.3% in the wet and dry seasons respectively.

All herds (grazing units) of cattle and other animal species observed within the two sampling strips were recorded, and a visual estimate of the number of animals they contained was made. On the basis of information collected in on the ground in neighbouring southern Gongola State (RIM, 1984), all small ruminants were considered to be sheep owned by pastoralists. When possible, grazing units of more than ten animals were photographed, so that definitive counts could be made, the daily bias of each observer calculated, and the initial estimations then corrected.

TABLE 1. PARAMATERS ESTIMATED FROM THE AIR.

WITHIN THE SAMPLE BAND

NUMBERS

Animals

Red Cattle, White cattle, Pastoralist Sheep, Horses and Donkeys, Wild animals

Habitation and Settlements

Arable, Agropastoral, Settled/Transhumant Pastoralist, Settled/transhumant Pastoralist with associated crops, Nomadic Pastoralist, Fishermen's
Tin and Grass roofs

Other

Deserted Coraals, Tar Roads, All Weather Roads, Tracks Deserted settlements and Habitations, Rivers and Open Water

WITHIN EACH GRID

Presence/absence of open water, % Cultivation, % Burned Ground, Gully and Sheet Erosion (each 0-5) % Closed Canopy Forest, % Open Canopy Woodland, % Savanna Woodland, % Grassland, Flying altitude, Grass cover (0-5)

Not all of these data are presented in the text, but are held in the RIM archive and are available on request.

The type of all human settlements within the sample strips was also recorded, and the number of dwellings they contained estimated. A distinction was drawn between arable habitation - dwellings without associated cattle corrals; and pastoral habitation - dwellings with associated corrals. Pastoral dwellings were further subdivided on the basis of structure and apparent degree of permanence. Permanent rectangular structures, or typical semi-permanent, round, beehive rugas were calssified as 'settled' pastoral; temporary shelters, either made from cut branches or crop stalks, were classified as 'nomadic' pastoral. During the dry season surveys, the 'settled' pastoralist dwellings were further divided into agropastoral - those having both cattle corrals and crops associated with them.

The term 'nomadic' is used here to signify probable short term occupancy indicated by the temporary nature of the structures, and to distinguish them from the more permanent beehive rugas of the 'settled FulBe. It does not necessarily reflect any fundamental difference in life-style or husbandry technique.

Once the numerical estimates had been corrected for observer bias and altitude deviation, the total population estimates for each parameter were calculated by applying the ratio method of Jolly (1969) as described by Norton Griffiths (1978) and used by Milligan et al (1979). In addition to the primary data collected, an index of vegetation density was derived for each grid cell based on the proportion of closed canopy forest, open canopy woodland, savanna woodland and grassland seen from the air.

Data handling and computer analysis were performed on a VAX 11-750 system and graphic displays were produced on an HP 7221 flat-bed plotter. Three closely related but distinct software packages were used concurrently: a purpose built programme for calculating the Jolly ratios; a Mapics data handling and graphics system; and the Minitab software package for statistical summaries and tabulations.

4. RESULTS.

4.1 Sorau

The survey zone occupied 1325 square kilometers of which 375 were designated as Grazing Reserve. Though some 40% of the area flown was comparatively mountainous, particularly in the central and southwestern regions, few of the grid cells were sufficiently steeply dissected to preclude grazing by cattle, these being limited to the areaimmiately bordering the southwestern edge of the Reserve. The vegetation was largely open canopy woodland, thinning to savanna woodland and grassland to the north and east near to the River Tsikakiri (SLAR map NC33-9). Cultivation levels were generally low, with a mean of some 6%, though reaching a maximum of 60% to the north and east of the Reserve itself (Table 2 and Map 2). With the exception of a limited central band near Zummo, little or no cropping was recorded in the western third of the survey zone.

As might be expected, water was recorded in a high proportion of the sample cells (53%) during the wet season, but in only 9% during the dry season. These permanent water sources were all in the south east of the zone, largely representing the River Tsikakiri or the dams to the west of Sorau. Open water was recorded only once in the Reserve itself (Map 2). It therefore seems that water availability may have been one of the major factors limiting the distribution of cattle in this region, particularly during the dry season.

The estimated cattle density was low when compared to those in the south of the State, and was marginally lower inside the Reserve than around its borders (Table 2). The cattle were fairly evenly dispersed throughout the region with the clear exception of the south east corner, near Sorau (Map 3). During the dry season, the density was markedly lower, averaging less than 6 animals per square kilometer, and was again lowest within the Reserve boundaries. The distribution of cattle closely

TABLE 2. SUMMARY OF NUMERICAL DATA FOR SORAU SURVEY ZONE

GENERAL INFORMATION

Area Flown (km^2)	1325	Area Reserved (km^2)	375
Mean % Cultivation	7	% Grids with dry season water	10

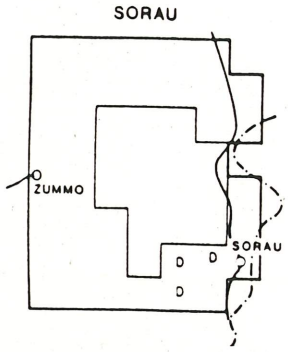
Dates flown: August 1983 and March 1984

POPULATION ESTIMATES

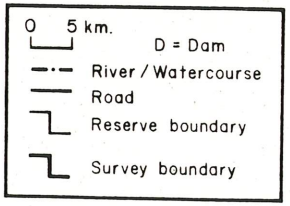
Parameter	Survey Zone		Reserve	
	Wet	Dry	Wet	Dry
Livestock				
Cattle No.	14,800	7,500	3,700	1,500
Cattle Density km^{-2}.	11.2	5.7	9.9	4.1
Sheep No.	4,900	9,300	1,200	2,000
Sheep Density km^{-2}.	3.7	7.0	3.1	5.3
Human Habitation				
Arable No.	26,500		5,100	
Arable Density km^{-2}.	20.0		13.5	
Agropastoral No.	290		0	
" Density km^{-2}.	0.2		0	
Settled Pastoral No.	320	430	210	160
" Density km^{-2}.	0.2	0.3	0.6	0.4
Nomadic Pastoral No.	530	80	60	20
" Density km^{-2}.	0.4	0.1	0.2	0.1

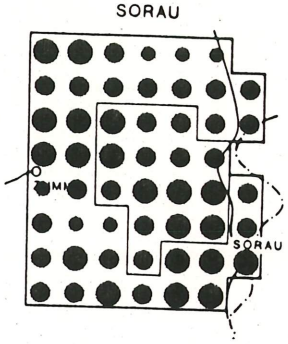
Agropastoral and Arable dwellings assumed to be aseasonal

MAP 2

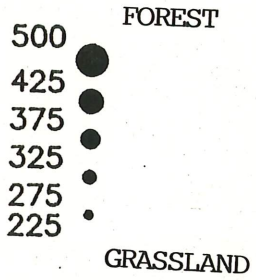


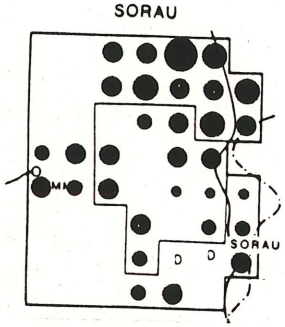
THE SURVEY ZONE



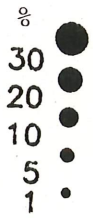


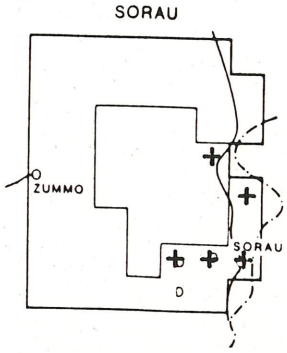
VEGETATION DENSITY INDEX





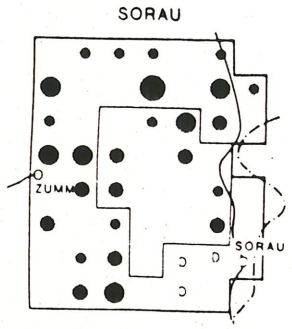
PERCENTAGE CULTIVATION

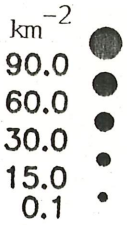




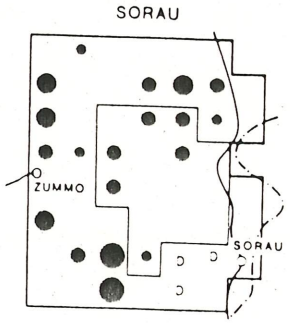
GRIDS WITH DRY SEASON WATER

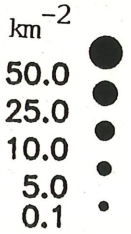
MAP 3



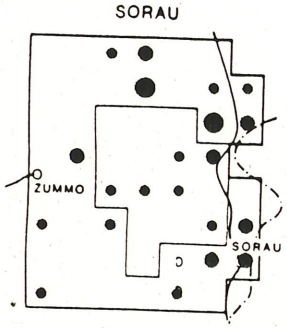


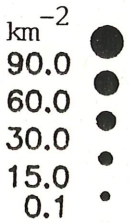
CATTLE: WET SEASON DENSITY



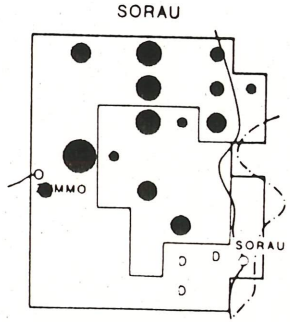


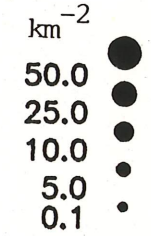
PASTORAL SHEEP: WET SEASON DENSITY





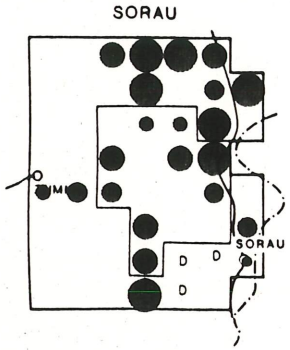
CATTLE: DRY SEASON DENSITY

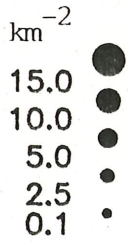




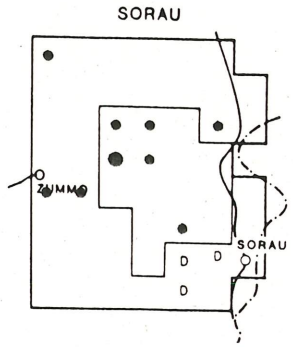
PASTORAL SHEEP: DRY SEASON DENSITY

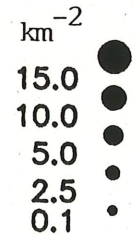
MAP 4



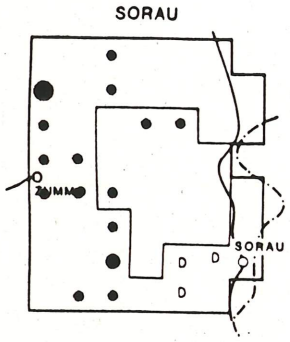


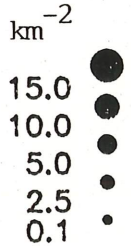
ARABLE DWELLING DENSITY



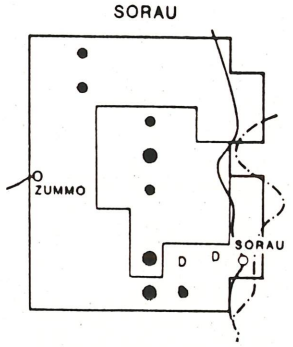


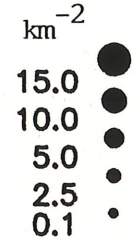
SETTLED PASTORALIST DWELLINGS: WET SEASON DENSITY





NOMADIC PASTORALIST DWELLINGS: WET SEASON DENSITY





SETTLED PASTORALIST DWELLINGS: DRY SEASON DENSITY

follows that of cultivation intensity, but may also reflect the distance of the northwestern quadrant from open water, and the comparatively mountainous terrain to the south-west.

The density of sheep was estimated to be some 4 per square kilometer in the wet season, rising to 7 per square kilometer in the following dry season (Table 2). Sheep numbers thus ranged from a third to one an a quarter those of cattle, depending on season, but the distribution patterns of the two species were similar (Map 3).

The numbers and densities of the various types of human habitation can be seen in Table 2. The arable dwellings were found to be heavily concentrated in the north-eastern part of the area surveyed (Map 4). Though significant numbers were recorded within the confines of the Grazing Reserve, the higher densities were in the regions surrounding it. Agropastoralists were few, and all to the north-east of the Reserve.

In contrast, the densities of 'settled' pastoralist dwellings were concentrated within the Reserve (Map 4), though overall mumbers were low in both seasons. The 'nomadic' pastoralist habitations were very sparse, particularly in the dry season, and their distribution pattern less closely associated with the Reserve.

4.2 Garkida

Of the 1600 square kilometers surveyed, 425 are within the Grazing Reserve boundaries. Unlike Sorau, most of this area is flat, containing as it does only four 5 x 5 kilometer grids with hilly terrain. The relevant SLAR vegetation and land use map (NC33-5) indicates an open woodland vegetation in the north which thins to the south, and includes fairly large patches of recently cultivated land to the east and west of the Reserve. The aerial survey results, however, suggest that the vegetation density is relatively even throughout the area flown, and that while

TABLE 3. SUMMARY OF NUMERICAL DATA FOR GARKIDA SURVEY ZONE.

GENERAL INFORMATION

Area Flown (km^2)	1600	Area Reserved (km^2)	425
Mean % Cultivatio	6	% Grids with dry season water	14

Dates flown: August 1983 and March 1984

POPULATION ESTIMATES

Parameter	Survey Zone		Reserve	
	Wet	Dry	Wet	Dry
Livestock				
Cattle No.	19,200	8,700	4,300	50
Cattle Density km^{-2}.	12.0	5.4	10.1	0.1
Sheep No.	4,400	5,400	1,100	730
Sheep Density km^{-2}.	2.8	3.4	2.5	1.7
Human Habitation				
Arable No.	16,200		4,400	
Arable Density km^{-2}.	10.1		10.4	
Agropastoral No.	0		0	
" Density km^{-2}.	0		0	
Settled Pastoral No.	750	430	40	60
" Density km^{-2}.	0.5	0.3	0.1	0.1
Nomadic Pastoral No.	90	60	20	40
" Density km^{-2}.	0.1	0.1	0.1	0.1

Agropastoral and Arable dwellings assumed to be aseasonal

cultivation is indeed restricted to the southern half of the survey zone, it is generally light - some 5% on average (Table 3 and Map 5).

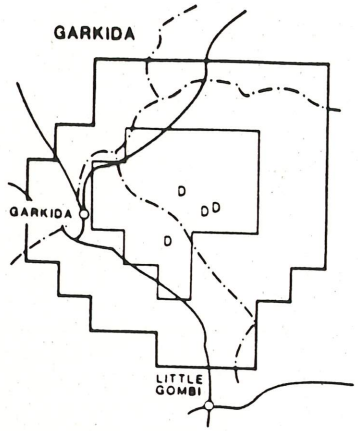
As in Sorau, water was widely available in the wet season, with 66% of the grid squares containing surface water, while in March 1984, it was limited to 14% of the sample cells, all of which lay in a central band stretching to the east of Garkida town. A third of the cells within the reserve held open water during the dry season, which includes three of the four dams (Map 5). Thus, no cell was further than 20 kilometers from permanent water, and as there was also dry season water to the south of the survey region, only a few to the north and east of the Reserve boundaries were further than 10 kilometers away from it. Water is therefore unlikely to be a major factor limiting the distribution of livestock in either wet or dry seasons.

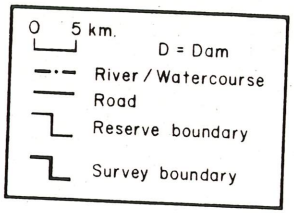
Overall cattle densities were very similar to those estimated for Sorau, in both seasons (Table 3). Again, there was a marked fall in the dry season, to approximately a half of the previous season's value, and again the densities inside the Grazing Reserve were lower than those in the surrounding land. This was especially evident during the dry season, when a mere 0.5% of the cattle recorded in the survey zone as a whole were actually within the Reserve itself, and the remaining 99.5% were distributed more or less evenly around its boundaries (Map 6).

The population density of pastoralists' sheep was in the region of 3 to 4 per square kilometer, and was higher in the dry season than in the preceeding July. Their distribution closely followed that of the cattle, though significant numbers were recorded within the confines of the Reserve during the dry season Table 3 and Map 6).

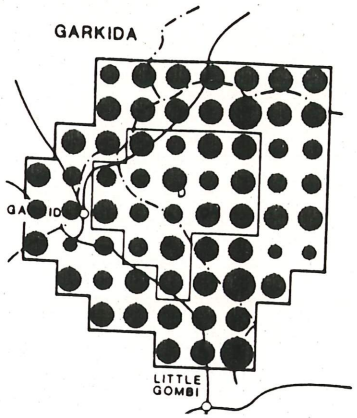
The number and density of arable dwellings recorded was low when compared to the other two sites surveyed and the distribution largely restricted to a band either side of the main road between Garkida and Little Gombi, and was concentrated in the

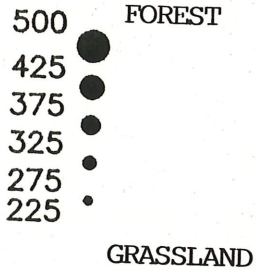
MAP 5



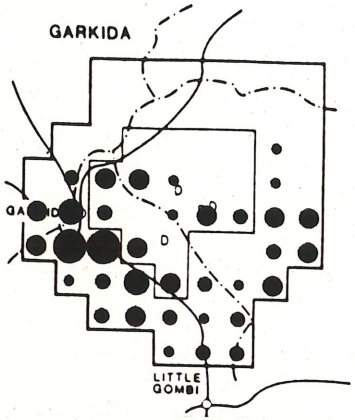


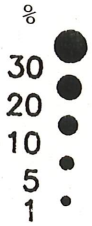
THE SURVEY ZONE



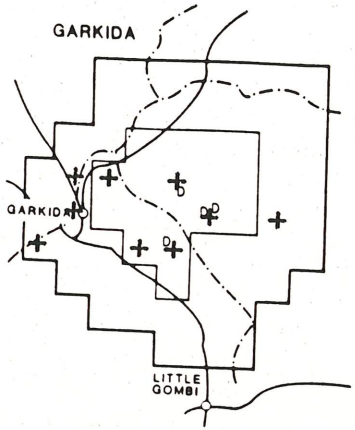


VEGETATION DENSITY INDEX



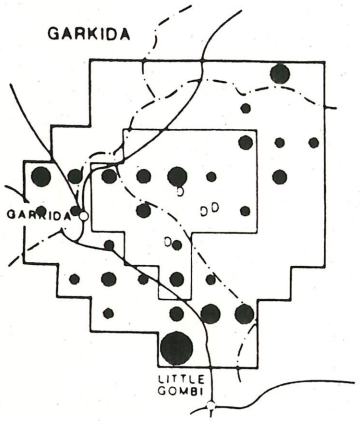


PERCENTAGE CULTIVATION



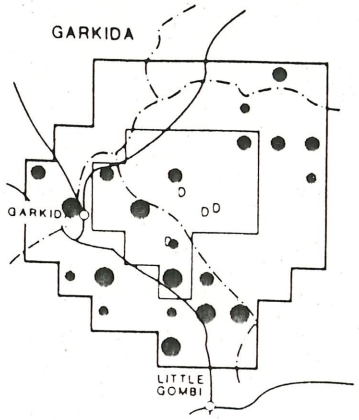
GRIDS WITH DRY SEASON WATER

MAP 6



km^{-2}
90.0
60.0
30.0
15.0
0.1

CATTLE: WET SEASON DENSITY



km^{-2}
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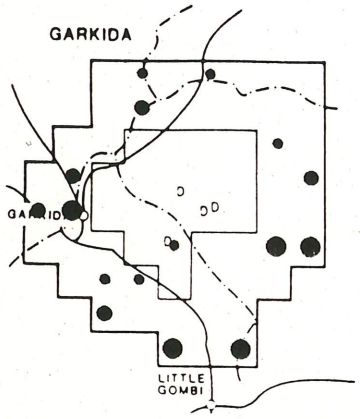
25.0
10.0
5.0
0.1

PASTORAL SHEEP: WET SEASON DENSITY



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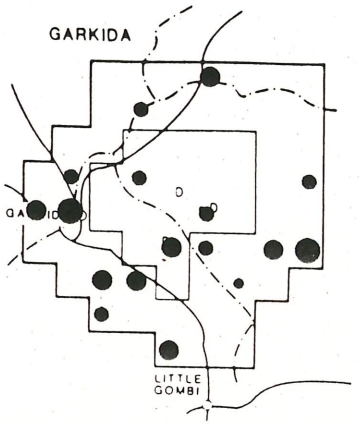
CATTLE: DRY SEASON DENSITY



km^{-2}
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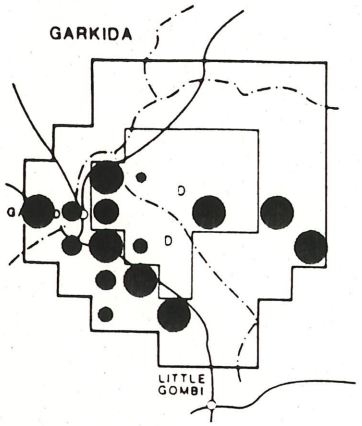
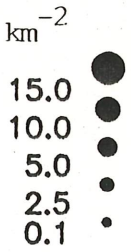
10.0
5.0
0.1

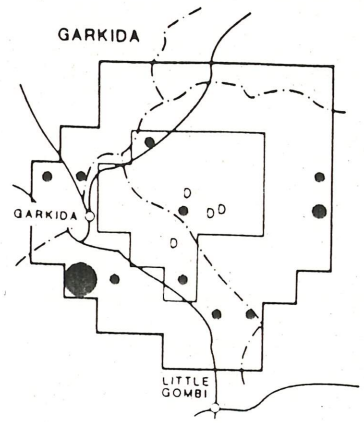
PASTORAL SHEEP: DRY SEASON DENSITY

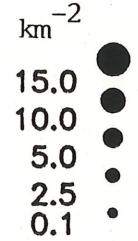
MAP 7



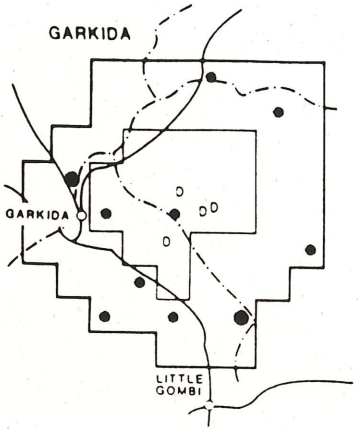


ARABLE DWELLING DENSITY

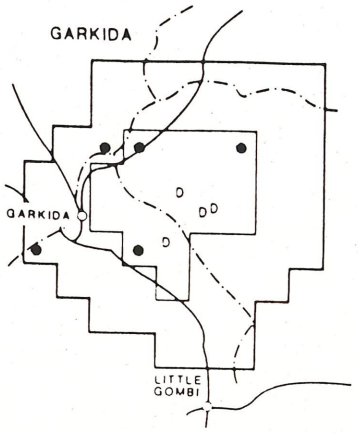




SETTLED PASTORALIST DWELLINGS: WET SEASON DENSITY



NOMADIC PASTORALIST DWELLINGS: WET SEASON DENSITY



SETTLED PASTORALIST DWELLINGS: DRY SEASON DENSITY

south-eastern corner of the Grazing Reserve (Table 3 and Map 7). Pastoralist dwellings of all types were sparse and evenly spread throughout the area flown. There is an indication that while the overall population levels fell between the two surveys, those within the Reserve boundaries were static, or may even have risen marginally after the wet season, though the numbers involved are too small to be conclusive.

4.3 Wawa Zangi

Of the three areas discussed in this report, Wawa Zangi was by far the largest (3750 km^2.) and with the Grazing Reserve itself occupying some 1725 square kilometers. The only elevated land in the region is a range of low hills between the railway and the eastern edge of the Reserve. The vegetation consists of relatively dense open canopy woodland inside the reserve boundaries, with more open savanna around its margins (SLAR NC32-8). Mean cultivation levels are higher than those found in either Sorau or Garkida, but are still only 8 to 10%. The areas of most intense cropping are concentrated along the three roads within the survey zone, particularly the one running alongside the railway to the east, and near to Duku in the extreme north-west (Table 4 and Map 8).

Despite the relative proximity of the Gongola River (5-15 km.), which lies to the north and east of the survey zone, very little open water was recorded in either season. During the dry season, in March, less than 5% of the sample grids held open water (Table 4). The dams that have been constructed along the road from Duku to Gadam were all empty, though surrounded by heavily overgrazed land, which suggests that they were important sources of water earlier in the dry season. As a result, up to 20% of the area is further than 20 kilometers, and a further 50% are more than 20 kilometers, from permanent water. The vegetation density index exceeds 375 in two thirds of these cells (Map 8), which represents thickly forested savanna, with little available pasture. Therefore, it is likely that on the grounds of pasture

TABLE 4. SUMMARY OF NUMERICAL DATA FOR WAWA ZANGI SURVEY ZONE.

GENERAL INFORMATION

Area Flown (km^2) 3750 Area Reserved (km^2) 1725

Mean % Cultivation 10 % Grids with dry season water 5

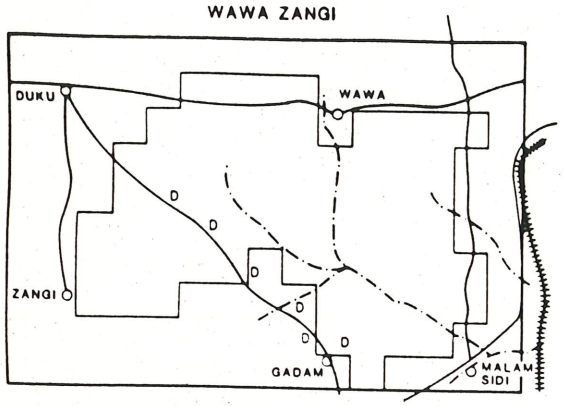
Dates Flown: August 1983 and March 1984

POPULATION ESTIMATES

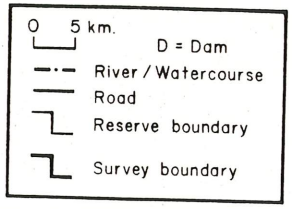
Parameter	Survey Zone		Reserve	
	Wet	Dry	Wet	Dry
Livestock				
Cattle No.	39,700	27,000	13,200	3,600
Cattle Density km^{-2}.	10.6	7.2	1.8	5.5
Sheep No.	6,700	20,700	3,500	3,200
Sheep Density km^{-2}.	1.8	5.5	2.1	1.8
Human Habitation				
Arable No.	44,200		11,700	
Arable Density km^{-2}.	11.8		6.8	
Agropastoral No.	4,100		1,100	
" Density km^{-2}.	1.1		0.7	
Settled Pastoral No.	1,600	600	800	220
" Density km^{-2}.	0.4	0.2	0.5	0.1
Nomadic Pastoral No.	1,800	310	1,330	70
" Density km^{-2}.	0.5	0.1	0.8	0.1

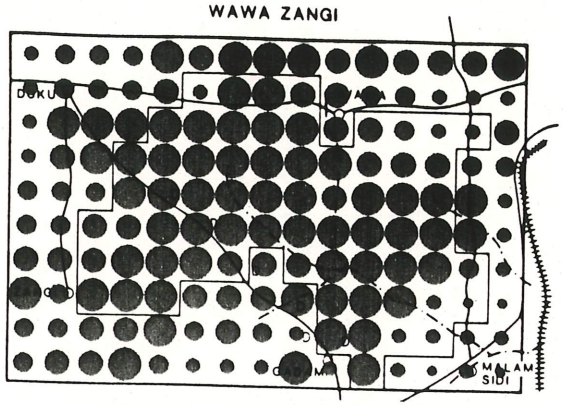
Agropastoral and Arable dwellings assumed to be aseasonal.

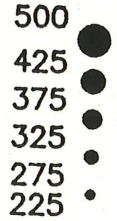
MAP 8



THE SURVEY ZONE



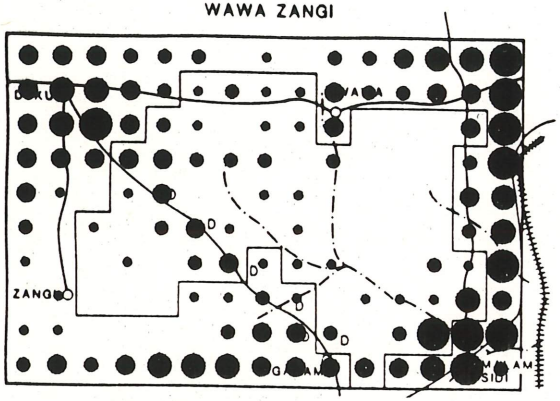


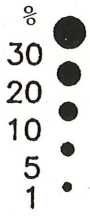


FOREST

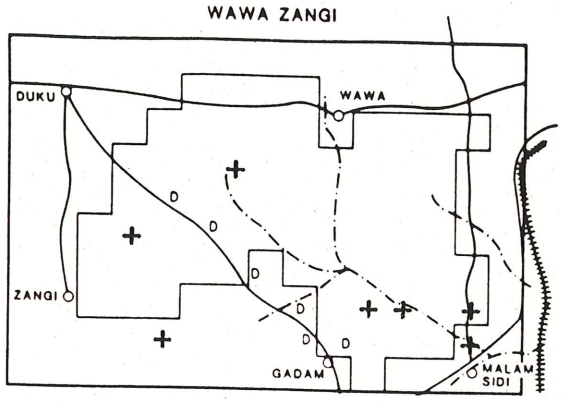
GRASSLAND

VEGETATION DENSITY INDEX



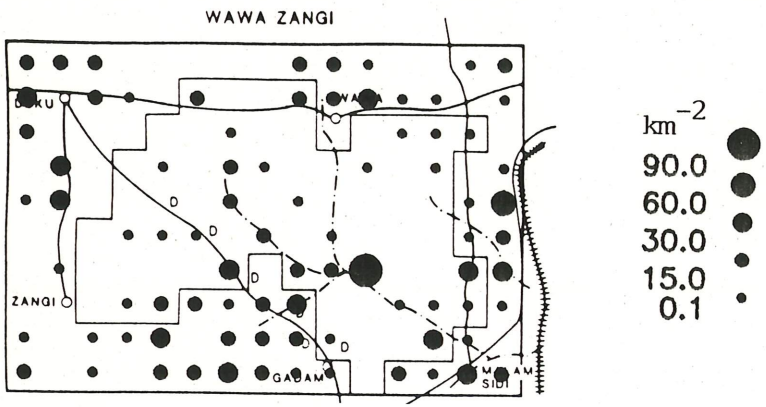


PERCENTAGE CULTIVATION



GRIDS WITH DRY SEASON WATER

MAP 9



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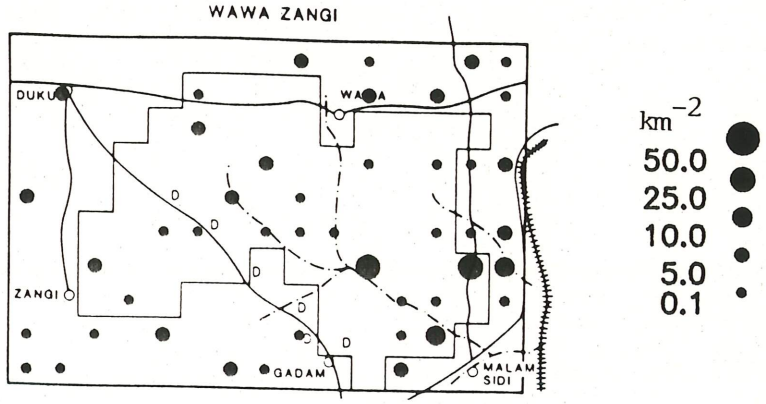
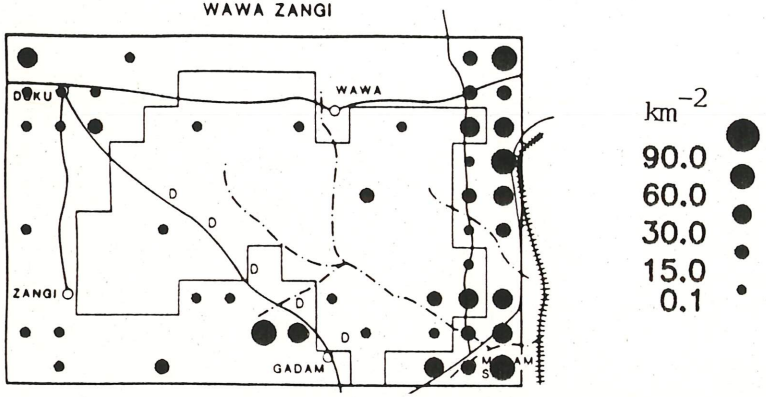


PASTORAL SHEEP: WET SEASON DENSITY



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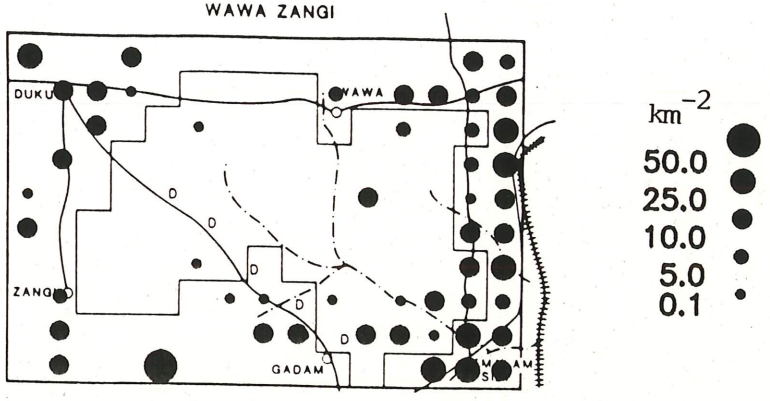
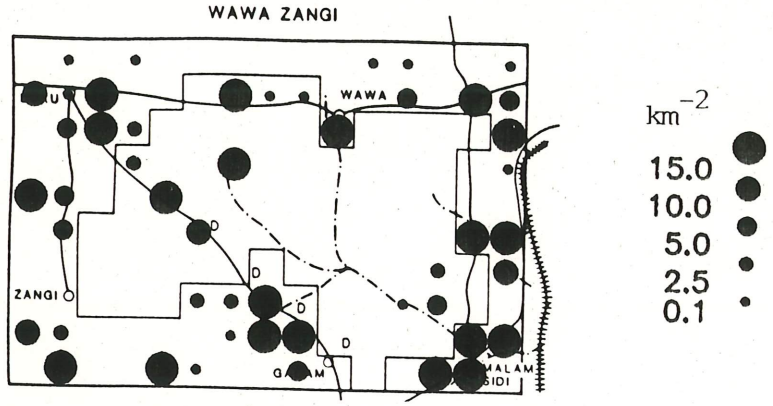


PASTORAL SHEEP: DRY SEASON DENSITY

MAP 10



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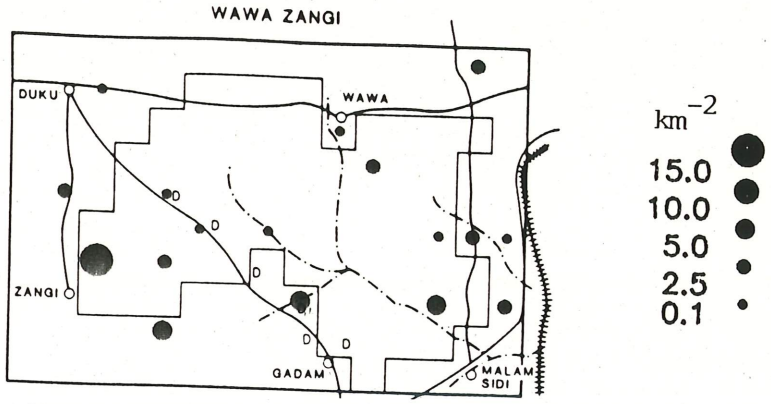
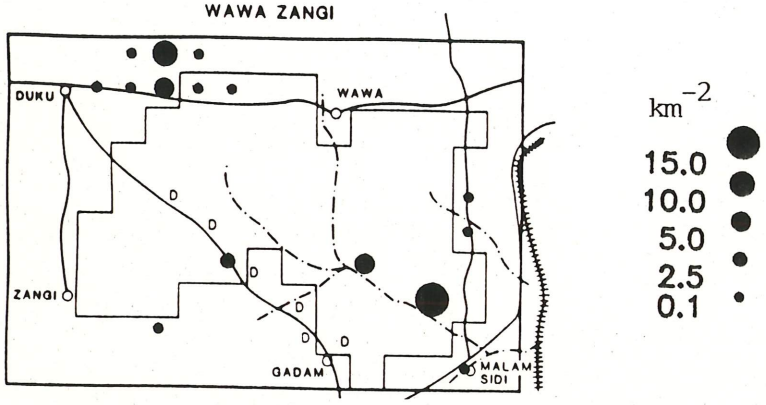
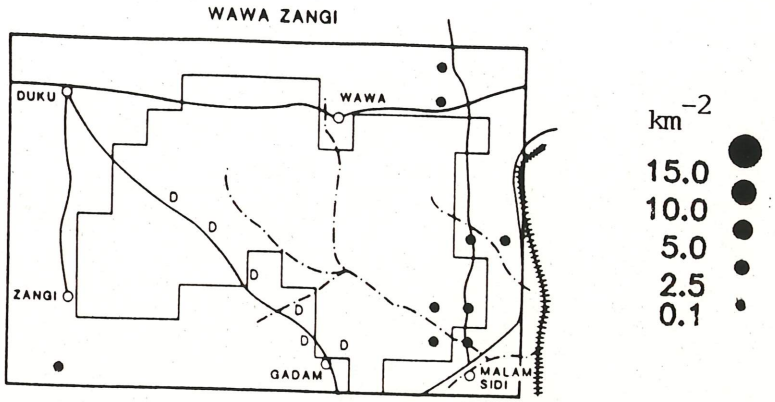


NOMADIC PASTORALISTS: WET SEASON DENSITY



SETTLED PASTORALIST DWELLINGS: WET SEASON



NOMADIC PASTORALISTS: DRY SEASON DENSITY

and water availabilty, over half the area surveyed is inherently unsuitable for year-round cattle husbandry, much of it within the Reserve boundaries.

The estimated cattle densities during the wet season were similar to those found in both Sorau and Garkida, at about 10 animals per square kilometer, and were also highest outside the Reserve. They were fairly evenly dispersed throughout the area, with no obvious centres of concentration. During the dry season, the overall numbers were slightly lower than those recorded previously, but the animals were found largely outside the Reserve boundaries, often in areas of relatively intense cultivation (Table 4 and Maps 8 & 9).

The density of pastoralists' sheep was considerably higher in the dry season than in the preceeding July when it was rather lower than that found in either of the other two survey zones described in this report. Their distribution pattern was very similar to that of the cattle (Table 4 and Map 9)

By virtue of its size, the number of arable dwellings found was high, though their density was considerably lower than that of Sorau. As might be expected, most of these dwellings were clustered along the roads, and showed a very similar distribution to that of cultivation. Pastoralist habitation was much increased by the presence of 4100 agropastoralist dwellings, of which some 20% were within the Grazing Reserve, while most of the remainder were close to its southern boundary. Of the less permanent pastoralist structures, the nomadic type were the most abundant during the wet season. They were largely confined to the southern half of the survey zone, and three-quarters were inside the Reserve itself. In contrast, the 'settled' pastoralist dwellings were grouped around Duku to the north west, and Malam Sidi to the south west. In the dry season, both types were much less frequent, and were essentially limited to sites along the railway line to the east (Table 4 and Map 10).

5. CONCLUSIONS

As no ground surveys were carried out in conjunction with this study, few concrete conclusions are possible concerning the efficacy of the Grazing Reserve development strategy. Essentially, therefore, this report provides a quantitative description of the numbers and distributions of livestock populations, human habitation and cultivation. These are factors which are of fundamental importance to the present management and future planning of Grazing Reserves and which can form a sound basis for future monitoring and evaluation.

Broad similarities exist between the three survey regions. In each of the three zones, sources of permanent water were probably sufficiently scarce to limit the distribution of livestock during the dry season, despite the presence of dams. This was especially true of Sorau, where the suitability for cattle may have been further reduced by the rugged terrain, and of Wawa Zangi, where the relatively dense vegetation may have had a similar effect.

In comparison to that of neighbouring parts of southern Gongola State during the same period, the cattle populations in all three areas were low and the sheep populations relatively high. Depending on season, cattle stocking rates in southern Gongola ranged from 6 to 11 hectares per head, and those for sheep from 66 to 76 hectares per head, compared with 8 to 18 hectares per head and 14 to 35 hectares per head respectively for the three Reserves.

The dry season cattle populations in Sorau and Garkida were approximately half those of the previous wet season, but this decline was less marked in the Wawa Zangi region.

In general, cattle were widely distributed throughout each survey site during the wet season. In the following dry season, however, they were considerably more clumped, especially in those areas which contained some cultivation.

In all cases, the cattle densities were lower inside the reserve boundaries than in the surrounding areas. This pattern was less evident during the wet season, when densities inside the reserves were 70 - 90% of those in the adjacent land, but was very obvious during the ensuing dry season, when the Garkida and Wawa Zangi Reserves, in particular, contained very few animals.

The sheep populations were generally highest in the dry season, when they were only slightly less than those of the cattle. Like the cattle, they were less abundant inside the Reserves than outside them, but in contrast, were less clustered during the dry season.

The density of human habitation within the three reserves was also low. The numbers of the pastoralist dwellngs changed substantially with season, the dry season figures being the lower.

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