

ABSTRACT

GREEN, ARTHUR GERRISH. Ethnic and Geographic Distribution of Natural Resource Management Strategies in the Tchabal Mbabo Region, Cameroon

Conservation and development projects in Africa are now attempting to implement participatory approaches to protected area management. These approaches remedy many past sources of conflict between local communities and conservation projects, but also potentially cause as many problems as they remedy when user groups are not accurately defined. Lack of appropriate definition of pastoral and some agropastoral groups commonly occurs due to limitations in projects' funding and time as well as specific characteristics that make these groups difficult to work with in participatory projects. More efficacious methods of user group identification focused on traditional divisions in social structures or geographic distribution of communities could possibly assist in project implementation. This study explores whether differences of natural resource management (NRM) behaviors in Tchabal Mbabo (Cameroon) are positively associated to social divisions. The three groups of interest here are subethnic divisions of Fulbe agropastoral groups: the Djafoun Mbororo, Akou Mbororo, and Huya Fulbe subethnic groups.

Fifty-five behaviors were chosen from a survey of 205 households. Data were coded and analyzed using Pearson's Chi-square test and the Kruskal-Wallis rank sum test ($\alpha=.05$). Thirty-seven of the 55 variables showed significant differences according to subethnic group. A second part of this study uses data collected during 20 months of participant-observation to create a series of descriptive profiles focused on NRM. Finally, all data is geographically referenced in order to assist further policy development, to create an historic reference for future research, and to lay the groundwork for longitudinal and exploratory research on the spatial distribution of ecological indicators and demographic characteristics. The results of this study are particularly relevant for the *Gashaka Gumti-Tchabal Mbabo Transboundary Conservation Project*, an integrated conservation and development project, in the region. The policy implications are explored.

**ETHNIC AND GEOGRAPHIC DISTRIBUTION OF
NATURAL RESOURCE MANAGEMENT STRATEGIES
IN THE
TCHABAL MBABO REGION, CAMEROON**

by

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A thesis submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the Degree of
Master of Science

NATURAL RESOURCE MANAGEMENT

Raleigh

2005

APPROVED BY:

Chair of Advisory Committee

BIOGRAPHY

Arthur Gerrish Green IV (Gill) was born the 7 November 1975 in Greensboro, N.C. He received his BS *cum laude* in International Studies and Sociology/Anthropology from Guilford College in 1999. Green also completed a year of study at both The American University in Washington, D.C. (1994-1995) and in the intensive Japanese language program at the International Christian University in Tokyo, Japan (1996-1997). Green's commitment to service has allowed him to participate in many volunteer positions including work as a citizenship and English instructor for refugees and immigrants through the *Americorps ACCESS* program in 1999. After his period at *Americorps*, Green began to work in the field of international development. Green's involvement with agricultural and natural resource development projects includes work in Thailand, the Philippines, Cuba, New Zealand, Brazil, and Cameroon. In 2001 Green began his Masters of Science in Natural Resource Management through the *Masters International Program* at North Carolina State University. In 2001-2002, Green worked as a research assistant at CAMCORE (an international tree domestication and conservation program based out of NCSU). In 2002-2004 Green conducted his MS research in Cameroon in order to assist a participatory development initiative between local populations and the UNDP-GEF funded *Gashaka Gumti-Tchabal Mbabo Transboundary Conservation and Development Project*. During this period he also served in *Peace Corps* as an agropastoral extension agent and as a consultant to NGOs working on the Adamaoua Plateau. Green returned to NCSU in 2004-2005 to write his thesis and earn his MS of Natural Resource Management with a minor in Geographic Information Systems. Green's studies and work in international development projects and geographic information technology has allowed him to become conversant in Japanese, Spanish, French, and Fulfuldé.

ACKNOWLEDGMENTS

My deepest gratitude goes to my mother who has shown me through her life and work that I can do anything I set my heart on, and to my father who has used his life to teach his children the values of patience, loyalty, and, above all, a reverent curiosity. Of course, I would not have been able to conduct this study without the capable guidance of Dr. Erin Sills and my committee. Moreover, specific thanks go to Jonas Tchinelé for his comradery and advice, Dennis Anye Ndeh for his music and endurance, Elhadji Ewhambi for his guidance and his tea on the transhumance routes, Djarou Paul Iya and his family for levity and hospitality, George Yebit who gave me to Galim and gave Galim to me, the Gosi Family in Lompta and Tchabal Mbabo for taking this lost *gaynaako* under their wing, and finally the people of the Faro-et-Deo Department in Cameroon for allowing me to be a part of their lives and travails for two brief years. There are many others I would like to thank for their encouragement, but I will limit this last thanks to my brothers and sisters who know who they are. You give me encouragement to laugh and give me strength to share this laughter with others.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
BLI	Bird Life International
CBNRM	Community Based Natural Resource Management
FAO	United Nations Food and Agricultural Organization
GIC	<i>Groupements d'Initiatives Commune</i>
GEF	Global Environment Facility
GIS	Natural Resource Management
GGTM	Gashaka Gumti-Tchabal Mbabo Transboundary Conservation and Development Project
GPS	Global Positioning System
ICDP	Integrated Conservation and Development Project
IUCN	World Conservation Union
JGI	Jane Goodall Institute
KW	Kruskal Wallis
MBOSCUA	Mbororo Cultural and Development Association
MINEF	<i>Ministère d'Eau et Forêts</i> : Ministry of Water and the Environment
MINEPIA	<i>Ministère de l'Élevage, des Pêches et des Industries Animales</i> : Ministry of Cattle Raising, Fisheries, and Animal Industries
NEMP	National Environmental Management Plan
NGO	Nongovernmental Organization
NRM	Natural Resource Management
NTFP	Non-Timber Forest Product
UGICETA	<i>Union des Groupements d'Initiatives Commune (GIC) du Comité d'Eradication de Tsé-Tsé en Adamaoua</i>
UNDP	United Nations Development Programme
UTM	Universal Transverse Mercator
WGS	World Geodetic System
X ²	Chi-square

CHAPTER 1: INTRODUCTION

1.1 Problem Statement

In Africa, conservation and development projects have historically played a role in increasing conflicts by appropriating resources without recognizing the resource rights of local stakeholders (Amanor 2003; Niamir-Fuller & Turner 1999; Scholte *et al.* 1999; Iro 2005; Weladji 2003). Limits on access to resources have changed stakeholders' political and socioeconomic status and led to conflicts between and among conservation projects and marginalized communities (Bello 2004; Hall & Blench 1997; Kouokam & Ngantou 2003; Njiforti & Tchamba 1993; Scholte *et al.* 1999; Weladji 2003). The conflicts and resulting failures of projects to protect biodiversity have led *integrated conservation and development programs* (ICDP) to adopt new management philosophies that recognize the importance of local participation and incorporate the needs of stakeholder groups (Blench 1999; Boyd *et al.* 1999; Dunn *et al.* 2000; Mengang 1998; IISD 2004; Nelson 2004; Niamir-Fuller & Turner 1999). Despite this improvement, implementation of participatory approaches continues to be problematic for some specific resource user groups like pastoral and agropastoral communities.

For many centuries pastoralism has been an important and effective livelihood strategy in the marginal lands and erratic rainfall patterns of the African Sahel and Sudano-Guinean savanna belts (Boutrais 1995; Iro 2005; McCarthy 2004; Niamir-Fuller 1999). In northern Cameroon, traditional pastoralists are now adopting more sedentary, agropastoral systems due to pressures that have made extensive pastoralism no longer tenable (Anderson & Broch-Due 1999; Boutrais 1995; Fratkin 1997; Moritz 2003). One of the pressures forcing this change is a lack of available pasture resources caused by loss of traditional grazing lands to agriculture and the government and private appropriation of land (Fratkin 1997; Iro 2005; Kouokam &

Ngantou 2003; Woodhouse 2002). The former approaches to protected area management by conservation projects are a large part of conflicts among pastoral and agropastoral groups.

Unfortunately, identifying pastoralists as stakeholders and understanding their resource use is often difficult because they are remote, exclusive, socially complex, and sometimes itinerant groups (Bello 2004; Iro 2005; Niamir-Fuller & Turner 1999). These traits often encourage isolation of pastoral groups or treatment of the groups as a monolithic stakeholder group with similar natural resource needs and behaviors. Resultantly, pastoralists and agropastoralists are often the most marginalized of stakeholder groups with the least understood natural resource management uses. Conservation and development projects need more effective approaches for identifying and disaggregating pastoral stakeholder groups into groups that recognize specific natural resource management (NRM) behaviors.

In Africa, as in many parts of the world, NRM strategies are historically and intimately intertwined with ethnic and subethnic group identities (Blench 1999; Comaroff 1987; Niamir-Fuller 1999; Reader 1998; Turner 1999; Virtanen 2003). Both *etic* and *emic*¹ framing of ethnicity often incorporate underlying themes of ecological adaptation as important factors in the diachronic² evolution of ethnic identity (Boutrais 1995; Macheachern 2003; Harris 1966; Moran 1979; Moritz 2003; Salzman & Attwood 1996; Seymour & Smith 1986; Salamon 1992; Virtanen 2003; Woodhouse 2002). Despite this, conservation programs do not commonly use ethnicity or subethnicity to disaggregate stakeholders into relevant resource user groups.

¹ An *emic* perspective “focuses on the intrinsic cultural distinctions that are meaningful to the members of a given society.” Its opposite is an *etic* perspective that “relies upon the extrinsic concepts and categories that have meaning for scientific observers.” These perspectives can, obviously, overlap depending on the individual. (Pike 1954)

² A *diachronic* approach is used by Julian Steward and other functionalists to explore change of structural institutions over time and across societies. The opposite, a *synchronic* approach, is concerned with the role of institutions in maintaining structural equilibrium at a given point in time. (Moran 1979)

The ethnic Fulbe³ diaspora constitutes the single most important group of pastoralists spread throughout Sub-Saharan Africa (Blench 1994; Boutrais 1994). The cattle of Fulbe play a central role in local ecologies and economies by transforming sparse vegetation into stores of protein and wealth and fertilizing agricultural lands (Boutrais 1995; Blench 1994; Moritz 2003; Virtanen 2003). The Fulbe diaspora originated from the Senegal area but it is now composed of many fragmented subethnic groups across the region. These groups speak Fulfuldé, often hold cattle husbandry as one of the pillars of their culture, and identify a common ancestry. Around the Tchabal Mbabo plateau in Cameroon (*Figure 1.1*) there are three subethnic divisions of the Fulbe: the Huya Fulbe, the Aku Mbororo, and the Djafoun Mbororo. This study uses the case study of these subethnic Fulbe groups, which are involved with the *Gashaka Gumti–Tchabal Mbabo Transboundary Conservation and Development Project (GGTM)*⁴ (*Figure 1.2*), to explore the use of ethnic categories for identification and disaggregation of stakeholders into user groups that are functionally relevant to policy design and project implementation.

³ The use of the “*B*” character in Fulbe represents “an explosive *b* sound” in the *Fulfuldé* language spoken by the Fulbe (Noye 1989). The Fulbe are recognized, depending on the region, by many other appellations such as the Peul and the Fulani. The Fulbe in this region call themselves either *Fulfe ladde* (Bush Fulbe or Mbororo) or *Fulfe nuro* (Village Fulbe) (Virtanen 2003). The term Huya Fulbe is a term that is also sometimes considered synonymous with the sphere of *Fulfe nuro*. In the literature, the Aku are also known as Aku and Daneeji; the Djafoun are also known as Jaafun (Dognin 1981; Virtanen 2003).

⁴ Full title: *Transboundary Collaboration for Ecosystem Conservation: the Mountain Forests of Gashaka-Gumti National Park, Nigeria and Tchabal Mbabo, Cameroon.*

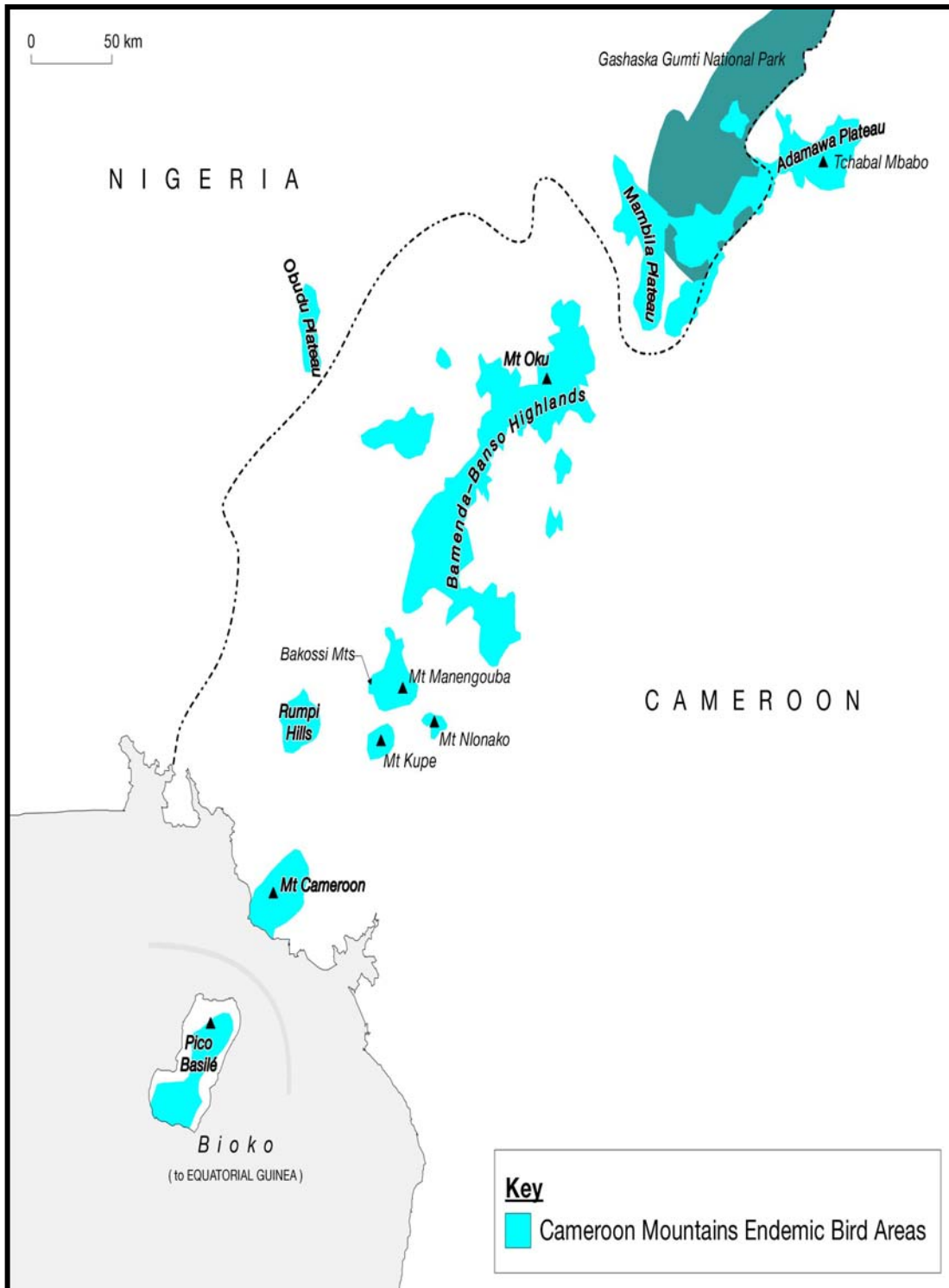


Figure 1.2: Map of the Cameroon Highlands, Gashaka Gumti National Park, and the Tchabal Mbabo region on the Nigerian and Cameroonian border (BLI 2005)

1.2 Purpose of Study

This study's geographic and demographic focus on agropastoralists⁵ settled around the Tchabal Mbabo plateau is related to the implementation of the *Gashaka Gumti–Tchabal Mbabo Transboundary Conservation Project* (GGTM), an integrated conservation and development project . The Tchabal Mbabo region is a highland area (elevation ranging from 1600m-2400m) located on the edge of the Adamaoua Plateau, in the remote west of Cameroon's Adamaoua Province. This study examines the relationship between natural resources management strategies and the subethnic identity of the three groups of agropastoralists in this region. The three subethnic groups of interest are the Aku Mbororo, Djafoun Mbororo, and the Huya Fulße (including the Ma'Ine). The ethnic categories used in this paper are recognized by the agropastoralists and by recent research in the area (Boutrais 1995; Guichard 2001; Tiayon 2004; Virtanen 2003). The geographic focus for this study limits our consideration to only these populations of agropastoralists.

GGTM is focused on conserving the rare, relatively unspoilt Afromontane forests and *forest-savanna ecotone*⁶ regions on the northern face of the Tchabal Mbabo escarpment. Protection of these areas would complete a transboundary protected area that covers the entirety of these endangered ecosystem that cross the boundary between Cameroon and Nigeria (Anye 2004; GEF 2001; Thomas & Thomas 1996). The rare Afromontane regions and the forest-savanna ecotone regions are currently protected on the Nigerian side by the *Gashaka Gumti National Park*,⁷ but they lack any protection on the Cameroon side. GGTM is a UNDP-GEF⁸ project

⁵ Despite the fact that some of the members of the subethnic groups may be considered pure agriculturalists or pure pastoralists, I will use the term *agropastoralist* to refer to the totality of subethnic groups throughout the paper.

⁶ According to Thomas & Thomas (1996) these *forest-savanna ecotones* are rare and important areas of botanic speciation that are critical for conservation. Tchabal Mbabo's northern escarpment may be the best example of an intact, gradual ecotone from Afromontane to lowland Sudano-Guinean savanna in West Africa.

⁷ Gashaka Gumti National Park is the largest park in Nigeria, it covers 6,670 km². The eastern boundary of the park is flush to the Cameroon border in the Adamaoua Province (Dunn *et al.* 2000). It has been operational as a park since 1991, but before that it existed as a game reserve.

which is being implemented by national agencies and two nongovernmental organizations, *BirdLife International* (BLI) and the *Nigerian Conservation Foundation* (NCF). Funding for the project comes from private donors, national governments and the Global Environment Facility (GEF) (Anye 2005; Bekker 2004).

Despite the fact that the initiative and funding for this project come from mostly external sources, the project places a heavy emphasis on participatory approaches that support sustainable development programs in local communities around the proposed conservation areas (Bekker 2004; WWF 2000; GEF 2001). In order to work with local communities, GGTM administrators have attempted to identify stakeholder groups⁹ in the region. During the stakeholder identification process, administrators recognized that the agropastoral communities located around the Tchabal Mbabo plateau constitute a critically important group of stakeholders that could determine the project's long-term success or failure (Bekker 2004; GEF 2001; ; Green & Tchinelé 2004; Tiayon 2004). Although this stakeholder group was recognized, specific resource management strategies and user groups are unknown (Anye 2004; Green & Tchinelé 2004; Tiayon 2004). In order to engage in participatory approaches such as *Community-Based Natural Resource Management* (CBNRM), GGTM must understand the specific behaviors of user groups (Soeftestad 2001).

The following is what GGTM knows of the actual natural resource management (NRM) strategies employed by the agropastoralists: The agropastoralists on Tchabal Mbabo have adopted different levels of agriculture to supplement their pastoral livelihoods (Boutrais 1995); the agropastoralists live next to and use resources from the Afromontane forests (Green &

⁸ United Nations Development Programme- Global Environment Facility.

⁹ In this study the term *stakeholder group* refers to an aggregate body of users of resources whose specific resource management patterns are vaguely known, if at all. The term *user group* refers to population segments whose resource management patterns are clearly specified. Specific *user groups* (Green & Tchinelé 2004; Vabi 1997) can and should be extracted out of the larger *stakeholder groups* that have been identified in the project literature (Tiayon 2004; Bombome *et al.* 2004; Wandji 2004).

Tchinlé 2004); they also practice a seasonal migration called *transhumance* across the northern face of the escarpment and ecotones region twice annually to lead an estimated 10,000-20,000 head of cattle to the Dodeo River Basin (Green & Tchinlé 2004; MINEPIA 2004); there is historic and anecdotal evidence that the subethnic groups practice different NRM strategies and are geographically clustered (Boutrais 1991, 1995; Green & Tchinlé 2004; Tiayon 2004). Recognizing pastoralists as a stakeholder group does not recognize the diversity of the agropastoralists NRM strategies or local organizations. Niamir-Fuller & Turner (1999) write in their review of research on pastoralism in Africa:

In considering development practice more focus should be placed on determining the diversity and heterogeneity of local systems, in order to design institutions, laws and policies that accommodate different needs... The elite have different expectations from those of the 'peasants'. Men and women control different functions. There are always minorities within a community, whether they are of a different ethnic background, or whether they are newcomers. Greater economic mobility in and out of pastoral communities has contributed to a greater diversity of needs, expectations, and power relationships. These factors need to be taken into account by any participatory project or programme that wishes to develop a sustainable system. They also determine the contents of the 'reservoir' of indigenous technical knowledge (ITK) that can be depended upon to develop new and innovative solutions and activities. (34)

It is not adequate to view pastoral communities as aggregate bodies, specifically in the context of the ethnic diversity and political structures on Tchabal Mbabo. It is necessary to disaggregate pastoralists and agropastoralists into user groups and understand their NRM strategies to develop policy and extension approaches that can efficiently foster improved natural resource management and avoid conflicts over resource access.

This study explores the use of ethnic categories for identification and disaggregation of the stakeholder group into user groups that are functionally relevant to the creation of conservation policy and project implementation. Ethnic categories are one of the most important ways in which the pastoralists on Tchabal Mbabo organize themselves (Boutrais 1995;

Green & Tchinelé 2004; Tiayon 2004; Virtanen 2003). Previous literature indicates that the subethnic categories in this region seem to be highly associated with many NRM behaviors (Blench 1999; Boutrais 1991, 1995; Green & Tchinelé 2004; Tiayon 2004; Virtanen 2003). In fact, the general and persistent connection between ethnicity and behaviors involved with natural resource management is widely recognized in academic fields (such as ecological anthropology, cultural ecology, historical ecology, and IK research) and in the applied development field (Harris 1966; Moran 1979; Salzman & Attwood 1996; Seymour & Smith 1986; Salamon 1992; Woodhouse 2002). Even so, using ethnic categories to disaggregate stakeholder groups into user segments that are reflective of NRM strategies is not a common approach among conservation and development agencies.

Two reasons that such an approach could be problematic are that it could deepen ethnic tensions in areas that are politically highly-charged and that ethnicity may or may not be highly associated with NRM due to the dynamic characters of ethnic identity and NRM in African pastoral communities. I would like to address both these points. To the contrary of the first point, the ability to exploit a real connection between subethnic groups and NRM strategies can lead to more efficient approaches to extension and may help mediate any future conflicts between competing groups. For the second point, the theoretic approach recognizing that both ethnicity and NRM are dynamic variables in a very complex network of socio-economic and ecological connections does not negate the historic or modern connection of ethnic categories to NRM behaviors.

This study fits into a larger body of work on pastoralist identity and resource management change in development and academic literature. Ethnic identity and NRM strategies are both separately considered to be dynamic variables in complex diachronic processes (Boutrais 1995; Harris 1966; Moran 1979; Moritz 2003; Salamon 1992; Salzman &

Attwood 1996; Seymour & Smith 1986). Despite agreement that these variables are in a constant state of change, the nature of that change and the processes which cause change are often in dispute. For example, in the case of our particular subethnic groups, some scholars suggest that as the Mbororo clans become sedentary and integrate into the Huya Fulbe lifestyle their subethnic labels are losing relevance (Frantz 1981; Moritz 2003). Frantz (1981) remarks that, “While the labels ‘Fulbe’ and ‘Mbororo’en’ have never been totally accurate or stable in time, they are progressively losing their value.”¹⁰ Despite that view, many other authors continue to see the relevance of these subethnic groups in spheres of NRM behavior, marriage patterns, language, genetics, and other criteria (Boutrais 1991, 1995, 1999; Guichard 2001; Virtanen 2003). Indeed, all points of view recognize the role that livelihood choices and NRM strategies played in the creation of these subethnic groups. The argument revolves on whether the attenuation of the ecological variables that formerly allowed continuation of the subethnic groups significantly changes the subethnic identity (i.e. the ability of the subethnic group to exist apart). While ethnic identity remains quite strong in Tchabal Mbabo, this study empirically tests the connection between subethnic categories and NRM strategies. Is there a difference between subethnic group NRM strategies?

This study does not imply cultural or environmental determinism. It rather leans toward historical ecology and ecological anthropology in understanding the diachronic nature of ethnicity and NRM strategies in a larger context (Attwood 1996; Balee 1998; Salamon 1992; Salzman & Seymour & Smith 1986; Steward 1955;). As Bastug (1998) wrote, rather than using kinship and kinship systems as a deterministic model, “the kinship structure should be regarded as providing inherent conditions which promote certain kinds of behavior in certain contexts and at the same time makes others less likely.” This study researches solely whether framing

¹⁰ *Mbororo’en* is the plural form of *Mbororo*. However, throughout this thesis I refer to them only as the *Mbororo* (in both singular and plural form).

natural resource management through subethnic categories is a plausible, appropriate, and practical approach for policy and extension development in African rural areas, and specifically in the case of GGTM and the Aku Mbororo, Djafoun Mbororo, and Huya Fulße.

1.3 Regional Ecology

1.3.1 Cameroon Highlands

The Cameroon Highlands traverse western Cameroon and southeast Nigeria from their southwestern extremity of Mt. Cameroun to their northeastern terminal point in the Tchabal Mbabo region (Anye 2004). Tchabal Mbabo is actually a remote plateau; however, in development literature it is commonly used to refer to the entire highland area surrounding the plateau. The Cameroon Highlands ecoregion constitutes the westernmost segment of what are called Afromontane ecologies (Thomas & Thomas 1996). Afromontane ecologies run in a swath across African highland regions from Malabo to Madagascar (Chapman 2004; Cunningham & Mbenkum 1993; Reader 1998; Thomas & Thomas 1996). The high rates of endemic and endangered species in Afromontane areas and the fact that Tchabal Mbabo's remote highland forests are relatively unspoilt compared to most other highlands, which typically have high population densities, led to the original conservation interest in this region (Chapman 2004; Cunningham 1992; GEF 2001).¹¹ It was later found that the region has a rare graduated vegetation change called a *forest-savanna ecotone* and that it is the location of heavily-used animal migration corridors between national parks in Nigeria and Cameroon (Bombome *et al.* 2004; Thomas & Thomas 1996).

¹¹ Cunningham (1992) found in Bwindi Impenetrable Park in Uganda agricultural population density between 50-100/km² and that 300km² of Afromontane forest was a relatively large example of intact Afromontane forests. In Tchabal Mbabo there is approximately the same amount of forest on the cliffs, yet the local population density estimates are less than 10/km².

1.3.2 Area of Interest

The Tchabal Mbabo plateau covers roughly 30,000 ha of pasture and gallery forests ranging from 1600m to 2400m in elevation. To the south, the plateau grades through a series of gorges into gently rolling hills that average 1200m-1400m elevations. To the north of the escarpment, a rapid loss of elevation from its highest point at 2400m to the Dodeo River basin at 600m creates dramatic, steep cliffs. The relatively intact Afromontane forests and smooth ecological transitions located in the flumed gorges of the steep northern face of the escarpment offer many microclimates important for speciation where rare genotypes may be located (Chapman 2004; Thomas & Thomas 1996). These forests are the core region of interest for GGTM. The project's buffer zones and multiple use areas compromise another 200,000 ha of surrounding forests and pasture lands. According to GGTM the area of interest is within the coordinates of 7°05'-7°30'N and 11°50'-12°20'E (Anye 2004; Shu 2004).

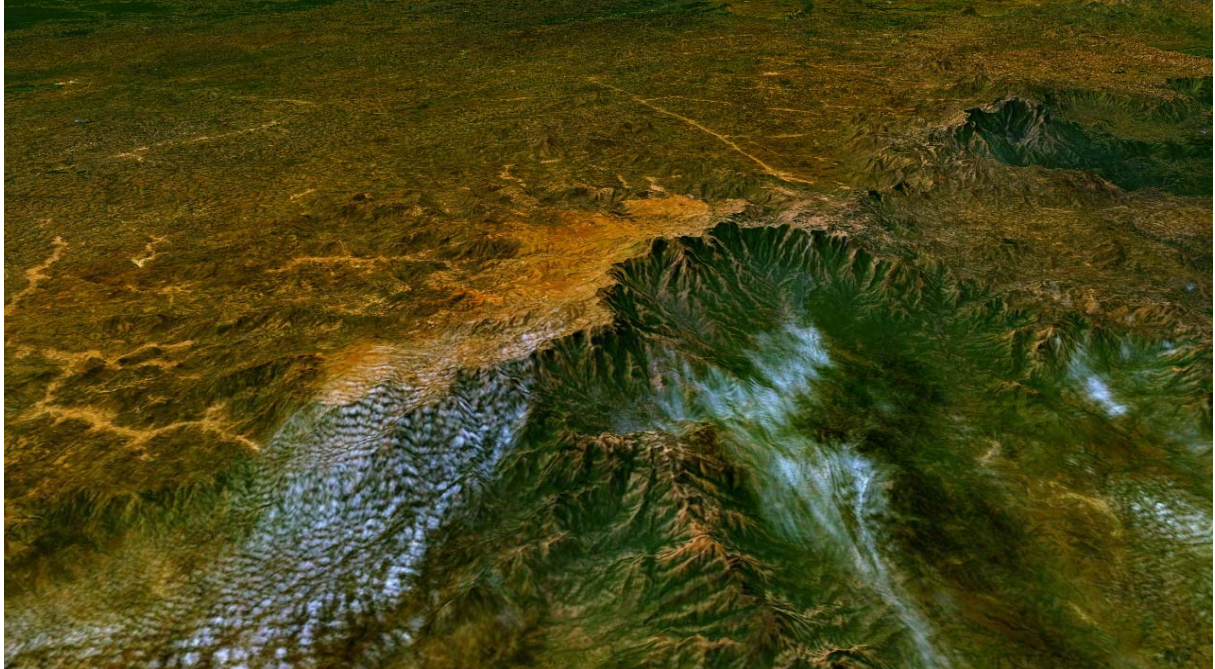


Figure 1.3: View of Tchabal Mbabo to the southwest (as rendered by *World Wind 1.3*, NASA). Notice the steep northern face of the escarpment where the flumed gorges support Afromontane ecologies. The white areas are clouds from the satellite image.



Figure 1.4: View of Tchabal Mbabo to the North. The Nigeria/Cameroon border is superimposed (yellow line). Notice the proximity of Nigeria, the rolling hill country to the south, and the lack of forest cover on the plateau as compared to the Dodeo River Basin north of the escarpment. (*World Wind 1.3*)

1.3.3 Geology and Soils

These highland regions are some of the oldest above ground regions in Africa (Reader 1998). The plateau's topsoil is characterized by ubiquitous, iron-rich ferralsols that are broken only by river galleries, gneiss and migmatite uplifts, and tertiary basalt represented by numerous volcanic plugs that have surfaced after centuries of erosion (Anye 2004; Boutrais 1995; Thomas & Thomas 1996). The soils are generally infertile and acidic unless manured or located on lower slopes where they are mixed with alluvium and organic matter to form rich, friable soils. The soils on the plateau closely match the FAO definition of ferrasols, "Ferralsols are soils that have a ferralic horizon at some depth between 30 and 200 cm from the soil surface. A ferralic horizon is a fine textured horizon which has been formed by strong weathering and leaching over a long period of time resulting in the accumulation of stable sesquioxides of iron and aluminium. Ferralsols are tropical and subtropical soils of old landscapes under high rainfall conditions.

They are usually very deep, yellowish to reddish coloured, extremely weathered and leached. Most of the soils are characterized by a high percentage of low-activity clay minerals such as kaolinite and sesquioxides (goethite, gibbsite, haematite). Hydrolysis of the silicate minerals, combined with rapid removal of weathering products leads to a low pH and low concentrations of weathered products in the soil solution. Acrisols and Ferralsols are most common in old land surfaces in humid tropical climates. They occur on gently undulating Tertiary and early Pleistocene erosion surfaces upon which repeated cycles of weathering, erosion and deposition have taken place” (FAO AGL 2000). Other than that, only thin lithosols are located on uplifted areas of gneiss and basalt (Anye 2004; Boutrais 1995). The distribution of soils has important implications for natural resource management decisions involving conversion of land to agriculture and choice of settlement locations.

1.3.4 Climate

Tchabal Mbabo is considered to have a perennially temperate climate. The plateau, receiving roughly 1700mm of rain a year, is slightly wetter than lowland regions (1300mm-1600mm). The plateau goes through a wet season (April-October) and a dry season (November-March), which is similar in length to the seasons of areas around the plateau. Yet the plateau receives more consistent rain and less evaporation than lowland areas thanks to the highland elevations and persistent fog. Temperatures are generally much cooler on the grassland plateau than in surrounding lowland areas, yet temperature ranges are also much greater on the plateau than in the regions surrounding it (Anye 2004). Temperature means hover around 22°C and rarely rise above 33°C. The colder climate of the plateau is due to elevation as well as a lack of windbreaks over the pastures; winds scour the nearly treeless plateau year-round from different directions depending on seasonal periods (Anye 2004; Boutrais 1995). This cold and windy climate is

especially attractive to the herders since the temperatures and winds keep many bovine pests away. However, the climate is very unattractive to agriculturalists (traditionally accustomed to growing millet and yams) because they did not until recently have cultivars that adapted to the cold climate and produced as well as lower elevation areas. Now varieties of corn are readily grown with other cold weather crops like potatoes and sweat pea.

1.3.5 Watershed Hydrology

Due to the seasonally abundant rain and the perennial springs located at what seems to be the very ridge line itself, Tchabal Mbabo has water supplied all year-round. Unfortunately, for the pastoralists, the low water levels during the dry season do not grow sufficient palatable grasses to support the number of cattle on the plateau. The plateau supplies two major rivers on opposite sides of the escarpment. The Benoué River is to the north and the Sanaga River is to the south. The Benoué River is supplied water via the small Mayo Yim catchment, located to the west of Fungoi, and by the Dodeo River basin which is fed by the entire northern face of the escarpment. The Dodeo River combines with the Faro River before it enters the Benoué River. The southern slopes form the watershed for the Sanaga River via the southwestern Mbam catchment and through the eastern Beli-Meng catchment which feeds the Djerem River before reaching the Sanaga River (Anye 2004; CARPE 2005; Thomas & Thomas 1996). The Afromontane ecologies and ecotones region guarantee the health of these headwaters. The importance of this fact cannot be understated when considering the entire region's ecologic and economic dependence on clean, downstream water and the resources the rivers provide. No studies have been done on sediment loads or volume in these headwater areas.

Water Catchments on Tchabal Mbabo

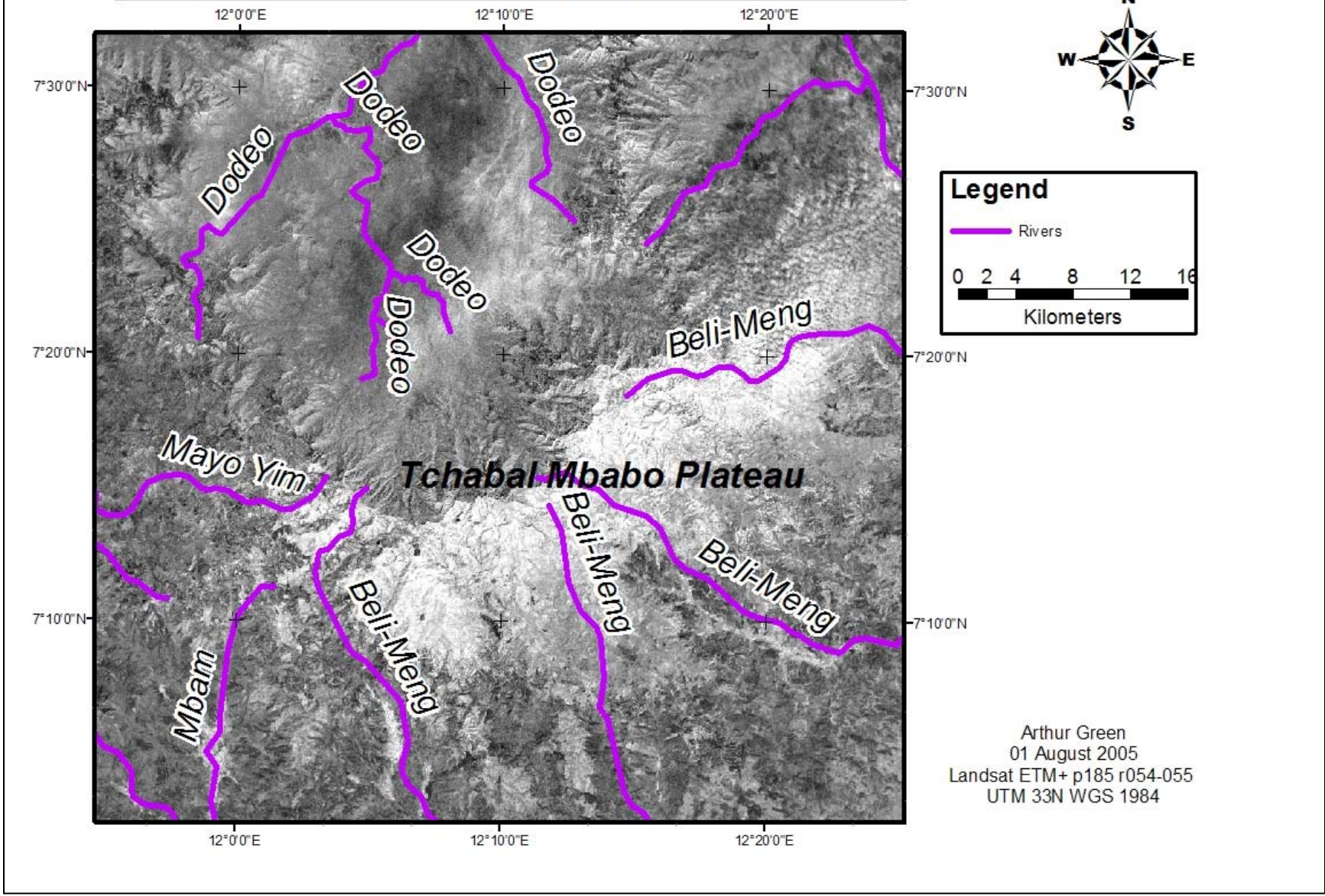


Figure 1.5 Water Catchments on Tchabal Mbabo

1.3.6 Flora

Two major botanic surveys have been conducted in this region (Chapman 2004; Thomas & Thomas 1996). Chapman outlined vegetation types (Table 1.1) and documented IUCN Red Data List Species (table 2.2). Thomas and Thomas (1996) found that the gradual vegetative change between the Afromontane forest and lowland Sudano-Guinean savanna, a continuous *ecotones* region, may be the most complete example of an ecotone in all of West Africa, and they found relatively intact Afromontane forests located above 1700m on the northern face of the escarpment. They ended by recommending that the ecotones and the Afromontane forests be protected by placing a core conservation area on the northern face of Tchabal Mbabo. One important note is that the classification schemes used by the two studies do differ (*Figure 1.3*).

The fact that the two studies recognized slightly different vegetation units in the area can probably be explained by the amount of time they were in the field (Chapman did substantially more fieldwork), the eight year gap between them, and the different satellite technologies available to Chapman and Shu (2004).

Table 1.1 Vegetation Types on Tchabal Mbabo

<i>Table 1.1 Vegetation Types on Tchabal Mbabo (Chapman 2004)</i>	
1.	Overgrazed <i>Sporobolus africanus</i> grassland
2.	Montane Hyparrhenia grassland
3.	Water seepages/bogs
4.	Montane escarpment forest
5.	Submontane forest
6.	Hyparrhenia savanna > 1500 m
7.	Hyparrhenia savanna < 1500 m
8.	Woody savanna/transition forest
9.	Savanna
10.	Lowland savanna
11.	Montane gallery forest
12.	Submontane gallery forest
13.	Lowland gallery forest
14.	Afromomum swamp forest
15.	Montane forest – grassland ecotone
16.	Cultivated flood plains with <i>Pennisetum purpureum</i>

Table 1.2 IUCN Red Data List Species on Tchabal Mbabo

<i>Table 1.2 IUCN Red Data List Species on Tchabal Mbabo (Chapman 2004)</i>	
<i>Chassalia laikomensis</i>	Cheek (CR A1)
<i>Dombeya ledermannii</i>	Engl. (CR A1c)
<i>Eugenia gilgii</i>	Engl. and Brehm. (CR A1c)
<i>Helichrysum cameroonense</i>	Hutch. and Dalziel. (LR/nt)
<i>Khaya grandifoliola</i>	C. DC. (VU A1cd)
<i>Lobelia colummaris</i>	Hook. f. (LR/nt)
<i>Millettia conraui</i>	Harms. (VU A1c, B1+2c)
<i>Peucedanum angustisectum</i>	Norman (LR/nt)
<i>Pouteria altissima</i>	Baehni. (LR/cd)
<i>Prunus africana</i>	Hook (LR/nt)
(CR) Critically Endangered	
(VU) Vulnerable	
(LR/nt) Lower risk and near threatened	
(LR/cd) Lower Risk and conservation dependent	

Table 1.3 Comparison of Vegetation Types found by Thomas & Thomas (1996) and Chapman and Shu extracted from Chapman (2004).

Chapman and Shu (2004)	
Mapped Vegetation Units	Included Vegetation Types
> 1700	
Montane escarpment forest	<i>Prunus africana</i> dominated forest <i>Afromomum</i> swamp forest
Montane gallery forests (above 2000 m)	<i>Ilex mitis</i> dominated forest <i>Syzygium guineense</i> sub sp. cf <i>bamendae</i> dominated forest <i>Albizi Albizia gummifera</i> – <i>Nuxia congesta</i> – <i>Prunus africana</i> dominated forest
Montane forest – grassland ecotone	<i>Hyparrhenia</i> grassland
> 1500 m	
Overgrazed <i>Sporolobus africanus</i> grassland	Water seepages / bogs Cultivation
<i>Hyparrhenia</i> savanna	
2000 – 1500 m	
Submontane escarpment forest	
Submontane gallery forest	
1500-700 m	
<i>Hyparrhenia</i> savanna	
Woody savanna/ transition forest	
Lowland gallery forests	
<700	
Lowland Savanna	
Lowland gallery forests	Cultivated flood plains with <i>Pennisetum purpureum</i>

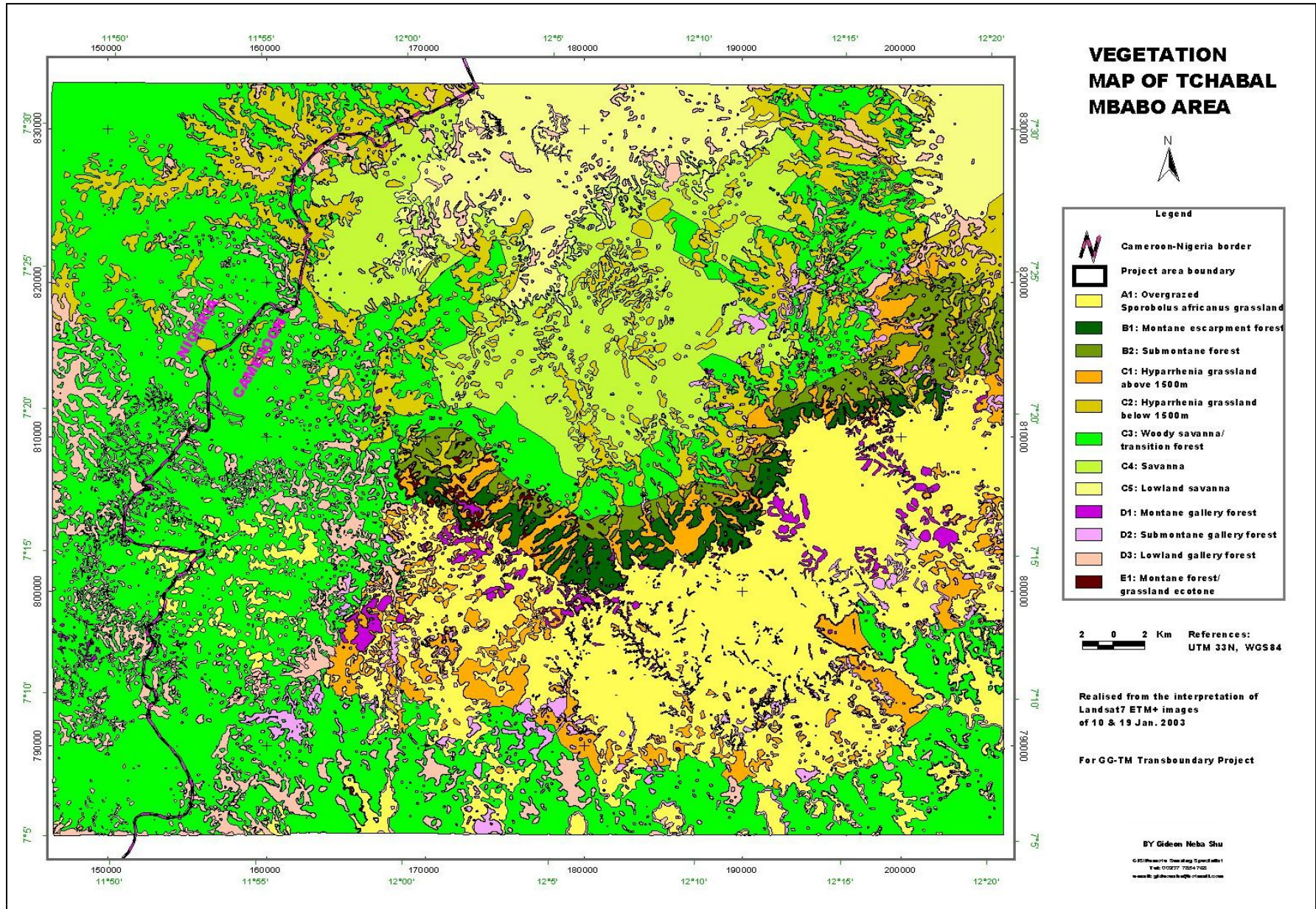


Figure 1.6 Vegetation Map of Tchabal Mbabo Area extracted from Chapman and Shu (2004)

Chapman (2004) conducted the most recent field survey of vegetation types for GGTM. Chapman found 16 vegetation types (Table 1.1) of which 12 were mapped (see *Figure 1.6: Vegetation Map of the Tchabal Mbabo Region*). Chapman also found that despite the erosion on hillsides and the presence of degraded pasture to the south of the escarpment, the region has not yet been as severely degraded by the presence of cattle as the Gashaka-Gumti National Park across the border in Nigeria. Chapman concluded by recognizing the importance of protecting these areas and the high amount of endangered species (*Table 1.2*) as the threat of degradation is real and urgent.

1.3.7 Fauna

During the period of January to March 2004, GGTM supported diversity inventories for mammals, birds, reptiles, and butterflies. The species counts were heavier in the forests of the Dodeo Basin than on the open pastures of the plateau (Bombome *et al.* 2004; Anye 2004). The spatial distribution and the types of species seen were certainly influenced by the period of observation, which occurred during the dry season period when most animals retreat from high and dry areas into the humid lowlands. In fact Mbororo pastoralists that were interviewed by Koki *et al.* (2004) confirmed that there is an “abundance of wildlife on the mountains (tchabal) during the rainy season due to floods in the plains and (an) abundance of green grasses on the mountains” (Anye 2004). The studies and local pastoralists confirmed a seasonal northeast to southwest migration corridor from the Faro National Park through the Dodeo River Plain and on to the plateau where the animals use river gallery forests to cross the plateau and move on to Gashaka-Gumti National Park in Nigeria. 33 mammal species were observed by Larison (1996),

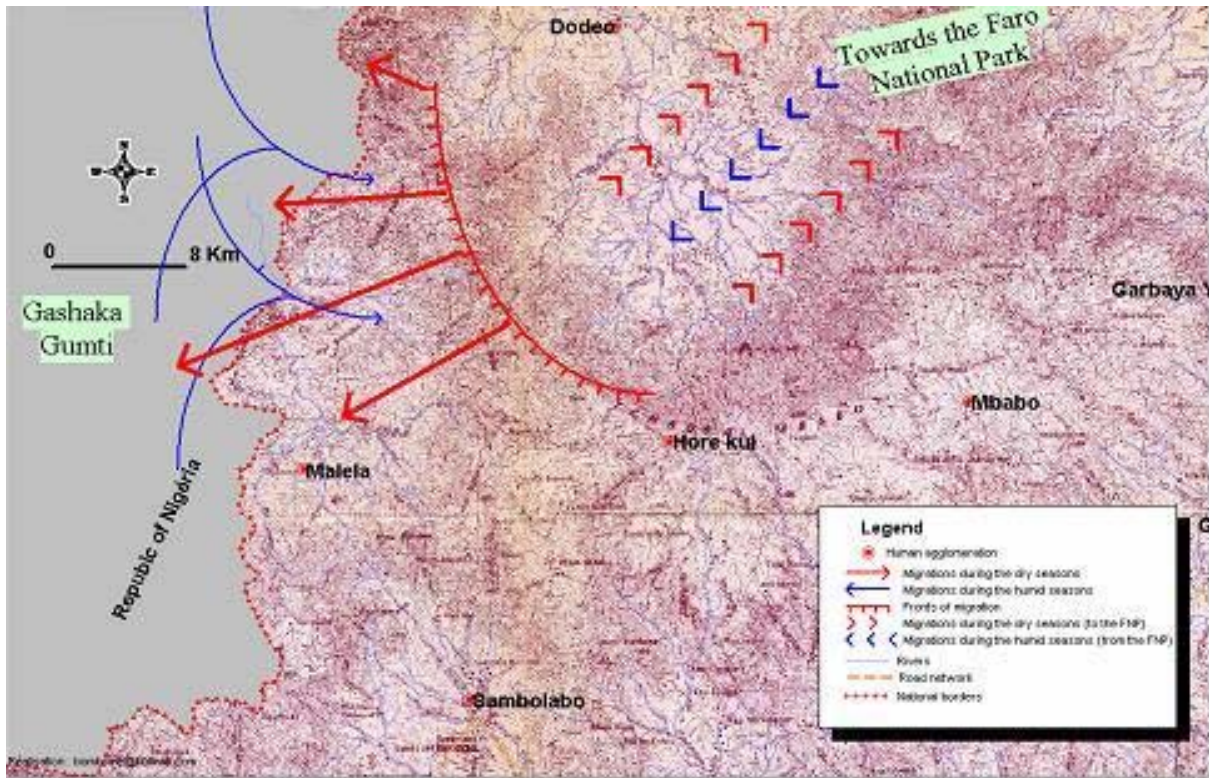


Figure 1.7: Wildlife Corridors in the Study Area (Bombome *et al.* 2004)

Smith and McNiven (1993), and Bombome *et al.* (2004). Anye (2004) summarized the mammalian diversity in the region:

Large mammals like Buffalo (*Syncerus caffer acuinotialis*), Buffoon Cob (*Kobus Kob*), Defassa waterbuck (*Kobus ellipsiprymmus*), Hartebeest (*Alcephalus buselaphus*) and Bushbuck (*Tragelaphus scriptus*) were reported. Smith found that, Yellow-backed duiker (*Cephalophus sylvicultor*) and Western bush buck (*Tragelaphus scriptus*) were common in the area while signs of western bush pig (*Potamochoerus porcus*), anteaters (*Orycteropus afer*) and spotted hyena (*Crocura crocuta*) were encountered in slope forests and the common warthogs (*Phacochoerus aethiopicus*) on the plateau. Other sightings included the bay duikers (*Cephalophus dorsalis*), Black and white colobus (*Colobus guereza*), tantalus monkeys (*Cercopithecus aethiops*) and baboons (*Papio cynocephalus*). Leopards (*Panthera pardus*) were apparently common on Tchabal Mbabo. Important findings of the surveys were the occurrence of threatened species like the “Endangered” African wild dog (*Lycaon pictus*), the “Data Deficient” Golden cat (*Felis aurata*), and the “Vulnerable” Lion (*Pantherus leo*), IUCN (2000). The Giant forest Hog (*Hylochoerus meinertzhageni*) and traces of Leopard (*Panther apardus*) were also recorded. Several species of large mammals like Black rhinoceros (*Diceros bicornis*), Giraffe (*Giraffa camelopardalis*), Cheetah (*Acinonyx jubatus*) and Derby Eland (*Tragelabus oryx*) mentioned by local people may have become extinct.

Although 294 bird species were recorded by three studies, Dongmo (2004) speculates that there are more species located in the region (Larison *et al.* 1996; Smith & McNiven 1993; Dongmo 2004). Tchabal Mbabo has 24 of the 44 species endemic to the Cameroon Highlands ecology. Among those 4 species (Bannerman's Weaver *Ploceus bannermani* "Vulnerable"; Cameroon Montane Greenbull *Andropadus montanus* "Near Threatened"; Bangwa Forest Warbler *Bradypterus bangwaensis* "Near Threatened"; and Crossley's Ground Thrush *Zoothera crossleyi* "Near Threatened") species are considered as globally threatened species according to IUCN categories. The studies found that there was a high degree of endemism in Tchabal Mbabo and as the most extreme example of range for many species it should be considered as Important Bird Area (IBA) CM009 and Endemic Bird Area (EBA) 086 (Anye 2004).

Studies on butterflies and reptile diversity also found interesting distributions and high diversity counts. 34 reptile species were recorded by Gonwouo and Lebreton (2004). The distribution of the species follows as Anye (2004) states: 17 belong to lowland savannahs, five to lowland forests, four to highland grasslands, two to highland forests and six occur in multiple habitats. The species include one crocodile, two tortoises, eleven lizards and 20 snakes. Many of the species were listed as CITES I and CITES II species: *Crocodylus niloticus* (CITES I), *Kinixys belliana*, *Python sebae*, *Chameleo v. weidersheimi*, and *Varanus niloticus* (CITES II). Tchabal Mbabo was found to be the richest in butterfly diversity of all summit sites in the Cameroon Highlands. 77 butterfly species belonging to nine families of Rhopalocera and one of Heterocera were found by Djieto (2004). Djieto also found that diversity counts were influenced by both elevation and vegetation type. The most abundant species counts were in high elevation forest galleries, which contained 57 species (of which 14 were limited to the vegetation type).

In conclusion, these studies show that Tchabal Mbabo has a high rate of endemism, serves as an important area for speciation, and functions as a home or important migration

corridor for many fauna. The fauna diversity and its distribution over the Tchabal Mbabo region have important implication for the design of a conservation core area and multiple-use zones around the core area.

1.3.8 Threats to Biodiversity and Natural Resources

There are threats to resources used by agropastoralists, threats posed by agropastoralists to resources, and other threats of concern to GGTM but not directly related to agropastoral activities. In some cases the agropastoralists on Tchabal Mbabo may be the main threat to the resources that they rely on for the families and cattle.

The agropastoralists rely on the local environment for water, medicine, fuelwood, and pasture resources. Agropastoralists are also increasingly involved in agriculture along stream beds and therefore reliant on soil fertility. The degradation of forest galleries and pasture makes it more difficult to raise cattle, practice traditional medicine, locate fuelwood, and find potable water. As well, as the watersheds degrade and erosion increases, agricultural productivity may decline. The agropastoralists' management of pasture resources, clearing of land for agriculture, and creation of new settlements have led to the degradation of Afromontane forests and ecotone regions (Boutrais 1995; Chapman 2004; Green & Tchinelé 2004; Thomas & Thomas 1996; Virtanen 2003). Although Bonkougou (2001) and other authors have noted the efficacy of traditional cattle management systems in maintaining the biodiversity of resilient dryland vegetation, the increasing rates of use and the local agropastoralists' relative lack of mobility does not follow traditional management practices or support local biodiversity. Over recent years, the types of demands on resources have diversified and the overall pressure on the land has increased due to an influx of new populations. An overabundance of cattle and agropastoralists is related to migrations to the plateau that were fleeing environmental or political insecurity in

the surrounding regions. They might give nuanced differences for causal relationships and culpability, but GGTM and the agropastoralists are in agreement that there has been a steady degradation of watershed and pasture resources, and that the over abundance of cattle from recent agropastoral migrations onto the plateau is largely to blame (Anye 2004; Bello 2004; Green & Tchinlé 2004).

Chapman (2004) noticed vegetation changes on the high plateau caused by the burning and overgrazing of pasture. The agropastoralists themselves complain of the widespread invasion of less palatable species such as *Sporobolus africanus* and *Pteridium aquilinum*, which are indicative of overgrazing and frequent fires and have started to take over much of the pasture areas on the plateau (Chapman 2004; Green & Tchinlé 2004; Thomas & Thomas 1996). In some areas of the plateaus erosion has become so widespread that pasture yield is reduced by up to 50% (Green & Tchinlé 2004; Tiayon 2004). A 77 year old Djafoun Mbororo bemoaning the land pressure remarked, “In the past there was grass above our heads, now the cows cannot find enough to eat.” Interestingly, there have been no geographic studies of the qualitative differences of pasture resources spread over Tchabal Mbabo, even as it is widely recognized that the pasture damage and subethnic groups are both geographically clustered (Boutrais 1995; Green & Tchinlé 2004; Tiayon 2004).

According to some authors widespread burning and overgrazing could indicate a lack of labor sufficient for herding (Blench 1985; Turner 1999). However, according to the agropastoralists burning on the plateau is primarily undertaken to stimulate growth from dry grass in order for non-transhumant cattle to have something to eat during the dry season. In the lowlands, fires are used to clear high grass, such as *Hyparrhenia* and *Pennisetum purpureum*, when it is dry and unpalatable, so that cattle and herdsmen can easily pass through the bush. In many areas, burning itself is not a problem since it maintains some native ecosystems by killing woody

vegetation. However, the frequency of burning and that the fires often enter into gallery and Afromontane forests are causes for concern (Figure 1.9). When forests receive fire damage, whether purposeful or through negligence, they often do not have enough time to recuperate because cattle move in and begin grazing. Thus forested area is gradually lost. Indeed, as pressure mounts for grazing areas on the southern slopes it seems that some of the herders may



Figure 1.8: Wildfire in Afromontane Vegetation; note the presence of bracken fern *Pteridium aquilinum*. Photo by Arthur Green, 2004.

be consciously clearing forest for pasture on the northern face of the escarpment. This clearing and grazing on steep slopes has significance to the health of the Dodeo watershed.

Agropastoralists also conduct other important activities on the northern face of the escarpment, including transhumance, fuelwood gathering, and medicinal plant extraction (Green & Tchinlé 2004). Transhumance activities occur throughout the northern escarpment. Multiple trails follow streams through the forest areas between the plateau and Dodeo River basin.

The main negative effects of the transhumance are the spreading of disease vectors between the domesticated and wild animals and the burning

of clearings throughout the ecotones region. The harvesting of medicinal plants and fuelwood in the forests of the plateaus is also of concern. With the exception of fuelwood, the extraction of plants seems to be quite low. On the other hand, the rate of fuelwood extraction is an issue. The impoverishment of many of the gallery forests on the plateau has led herders to seek fuelwood

off the escarpment. Some agropastoralists have responded to the fuelwood scarcity by planting eucalyptus. The eucalyptus plantations are a mixed blessing. They pose an additional threat to the environment as they naturalize along rivers to the south of the plateau; however, simultaneously, the eucalyptus lowers fuelwood demands on the remaining forests on the northern escarpment. In respect to threats to natural resources the agropastoralists are their own worst enemies.

The major threats to the regional biodiversity as found by GGTM are unsustainable extraction of vegetative resources, unsustainable hunting practices, deforestation for farming, overgrazing by livestock, and wildfires (Anye 2004). Unsustainable extraction of vegetative



Figure 1.9: Unsustainable, commercial harvest of rare *Prunus africana* near Hore Mayo Deo. The trees die due to the ringing. Photo by Dennis Anye, 2004.

resources, unsustainable hunting practices, and deforestation for farming are all activities that are not very common among the agropastoralists, with the exception of some Huya Fulße agropastoralists. The heaviest extraction of vegetative resources occurs primarily during the dry

season. The main resource of concern is *Prunus africana*. Bark harvesters often come from southern provinces to illegally extract the bark and sell it to exporters who make a medicine for benign prostatic hypertrophy (*Figure 1.9*) (Cunningham 1993; Tiayon 2004). Only commercial extraction is of major concern for this species; local use of the bark is at such a low level that it cannot be considered a dangerous extraction rate (Green & Tchinelé 2004; Tiayon 2004). In fact, local people have been told that the bark is valuable, but since they are unfamiliar with the market and do not want to engage in the labor intensive process, they do not play a role in the commercialization of this species. Extractors must pay a small amount of money to local chiefs in order to get extraction rights. Despite the illegal nature of this activity it is widely recognized that some government officials and representatives of the *Ministry of Water and the Environment* (MINEF) play a central role in the harvesting and selling of the bark.

Commercial and subsistence hunting for bushmeat is mainly practiced by non-Muslim or agricultural communities around in the area. The abundant wildlife and remoteness attract hunting parties from as far as Nigeria and Tibati (Tiayon 2004; Vabi 1997). Poachers have admitted that hunting on the Nigerian side of the border is much more risky due to the presence of park officials. Export of the meat occurs to places as far as the West Province where higher prices can be attracted (Vabi 1997). Some of the meat is sold or consumed locally in trading centers like Wogomdou, Galim, Tignére, or Mayo Baleo. The lowland populations depend on bushmeat and fishing for their protein needs during the rainy season when there are rarely cattle to be consumed in the Dodeo region (Boutrais 1995; Tiayon 2004; Green & Tchinelé 2004). Pastoralists are rarely involved, but this study found that some Mbororo and Fulbe do practice very low levels of hunting.

Deforestation for agriculture primarily occurs among agriculturalists who practice shifting agriculture or agropastoralists who settle in valleys next to streams and rivers. Although,

compared to sedentary agricultural populations they are few, evidence indicates that Huya Fulße populations located in the western and southern ends of the plateau are the most actively involved in clearing forest for agriculture of all the agropastoralists. In fact, most clearing occurs as part of new settlements. Many of the agropastoralists have been able to stay on one field and with consistently high levels of fertility due to the concentration of cattle manure in their fields.

1.3.9 Summary

Despite formidable threats to natural resources and biodiversity, the Tchabal Mbabo plateau and surrounding regions are an area of high endemic diversity and immense conservation value. The local economic reliance on this ecosystem and the presence of wild animal migration corridors, high counts of endemic species, intact ecological gradations (*ecotones*), and large tracts of Afromontane forests reveal the regional and global importance of protecting this area from immediate threats to its degradation. Although there are many groups of stakeholders, the local agropastoral communities have the most vested interest in adapting their management strategies to maintain the ecosystem. Moreover, their continued presence around the plateau means that they can be a great assistance for conservation by helping guard some natural resources which are endangered and hold commercial economic interest only for exploiters from other regions. In order to attenuate the threats and reverse current trends, GGTM will need to develop a comprehensive understanding of user group activities. It is possible that the pastoral kinship structure (subethnic categories) can help GGTM find out more about specific NRM strategies being employed and the distribution of user groups around the plateau.

1.4 Natural Resource Management in Cameroon

Approximately 11% of the Sub-Saharan African landmass is under protected status as defined by World Conservation Union (IUCN) Categories I-VI (IUCN 1994; WRI 2005). Few of these managed areas are considered to be successes at their central goal of conserving and sustainably managing natural resources. The reasons underlying failures are diverse, but administrative ineptitude and lack of local involvement in project planning and management are often cited as direct or ancillary causes for failure (Hall & Blench 1997; Njiforti & Tchamba 1993; IISD 2004; Kouokam & Ngantou 2003; Mayaka 2002; Nelson 2004; Scholte *et al.* 1999; Weladji 2003).

Recognition that previous management philosophies have failed to consistently produce successful projects has led conservation and development theory and practice in Africa to undergo dramatic shifts over the last 40 years (Amanor 2003; Dunn *et al.* 2000; IISD 2004; Mayaka 2002; Mengang 1998; Nelson 2004; Niamir-Fuller & Turner 1999). The original development of what are now known as protected areas in Africa began when colonial governments sequestered land for hunting reserves and created management plans for exportable resources (Biswas & Tortajada 1995; Boutrais 1995; Reader 1998). The management of these areas often excluded local people and resulted in direct or indirect conflicts over resource access (Hall & Blench 1997; Kouokam & Ngantou 2003; Mengang 1998; Nelson 2004; Njiforti & Tchamba 1993; Scholte *et al.* 1999; Weladji 2003). Thus an important and relatively recent evolution in the philosophy of protected area management in many areas of Africa is that local populations must play a role in the ongoing sustainable management of resources (Amanor 2003; Dunn *et al.* 2000; IISD 2004; Mayaka 2002; Niamir-Fuller & Turner 1999). Management philosophies now focus on participatory, integrated conservation and development approaches that involve stakeholder identification, clarity of resource access rights and tenure, and local capacity building (Bekker 2004; Dunn *et al.* 2000; IISD 2004; Mayaka 2002; Niamir-Fuller &

Turner 1999). Theory on how participatory approaches should be implemented and why they sometimes continue to fail best management guidelines have evolved through many paradigms, such as *Gestion de Terroirs Villageois* (GTV) and *Community Based Natural Resource Management* (CBNRM) (Amanor 2003; Dickson & Hutton 2001; Dunn *et al.* 2000; IISD 2004; Soeftestad 2001; Turner 1999). Currently, adoption of CBNRM and *adaptive management* principles is being encouraged throughout much of the region (Bekker 2004; Dunn *et al.* 2000; Mayaka 2002; Salafsky, Margoluis, & Redford 2001; Soeftestad 2001).

The process of transforming from exclusive to participatory management systems is not an easy one. When Cameroon gained independence in 1961 it inherited a system of game reserves and a body of resource management legislation largely based on the French colonial government (Biswas & Tortajada 1995; IISD 2004). Since then various protected areas have been added throughout the country as seen appropriate by international conservation interests and national prerogatives. However, until Cameroon established its National Environmental Management Program (NEMP) in 1992 it worked under property and tax legislation that was largely based on colonial precepts and effectively discouraged long term local and private investment in resource management (Bekker 2004; Biswas & Tortajada 1995; IISD 2004; Mengang 1998). By modifying existing legislation through the NEMP, Cameroon attempted to implement more participatory management strategies in order to change trends of resource management failure and meet the demands of tight budgets, international donor bodies, and international and regional conventions of which Cameroon participates (Anye 2004; Mengang 1998; Turner 1999; WRI 2005). The NEMP has appeased donors and international and regional conventions. However, despite the commendable adoption of such legislation, implementation is far from uniform. It is arguable whether the NEMP has actually facilitated implementation of the more participatory approaches to conservation (IISD 2004).

Common to the participatory conservation management philosophies that the NEMP endorses is the identification and active participation of stakeholder groups in conservation and development projects. This is a formidable obstacle in Cameroon and many developing countries. In Cameroon, identifying stakeholder groups and maintaining relations with them are often difficult tasks to perform due to a lack of administrative adherence to national standards (usually due to corruption or ignorance of standards)¹², the existence of strong ethnic stereotypes, and a regional lack of management expertise to meet the immense challenges posed by diverse types of user groups claiming unique resource access rights in many different ecological settings (Biswas & Tortajada 1995; IISD 2004; Mengang 1998).

The endemic diversity of Cameroon and its stakeholder groups renders formulaic management inutile and requires a large level of technical and linguistic expertise that simply doesn't exist (Bekker 2004; Mayaka 2002; Temu *et al.* 2005). Cameroonian conservation areas cover the gamut of Sub-Sahara African ecologies from the deep Congo forests (Lobéké) to mangrove swamps (Douala-Edea Faunal Reserve), to the Afromontane highlands (Kilum-Ijim), and on to arid Sudano-Guinean parkland savannas and the Sahel towards Lake Chad (Benoué and Waza) (*Figure 1.10*) (CARPE 2005). Over 8% of Cameroon's 455,440 km² of national territory is under protected status. Over 20% of the parklands and savanna area is protected (WRI 2005). International donors call for approximately 20% of the entire country to eventually be under some form of protected status in the next 20 years (Anye 2005; Biswas & Tortajada 1995).

¹² Cameroon is consistently ranked in the top ten most corrupt countries in the world by Transparency International. In 2003 it came in 7th in total corruption in the world (Transparency International 2004).

Ecoregions of Cameroon

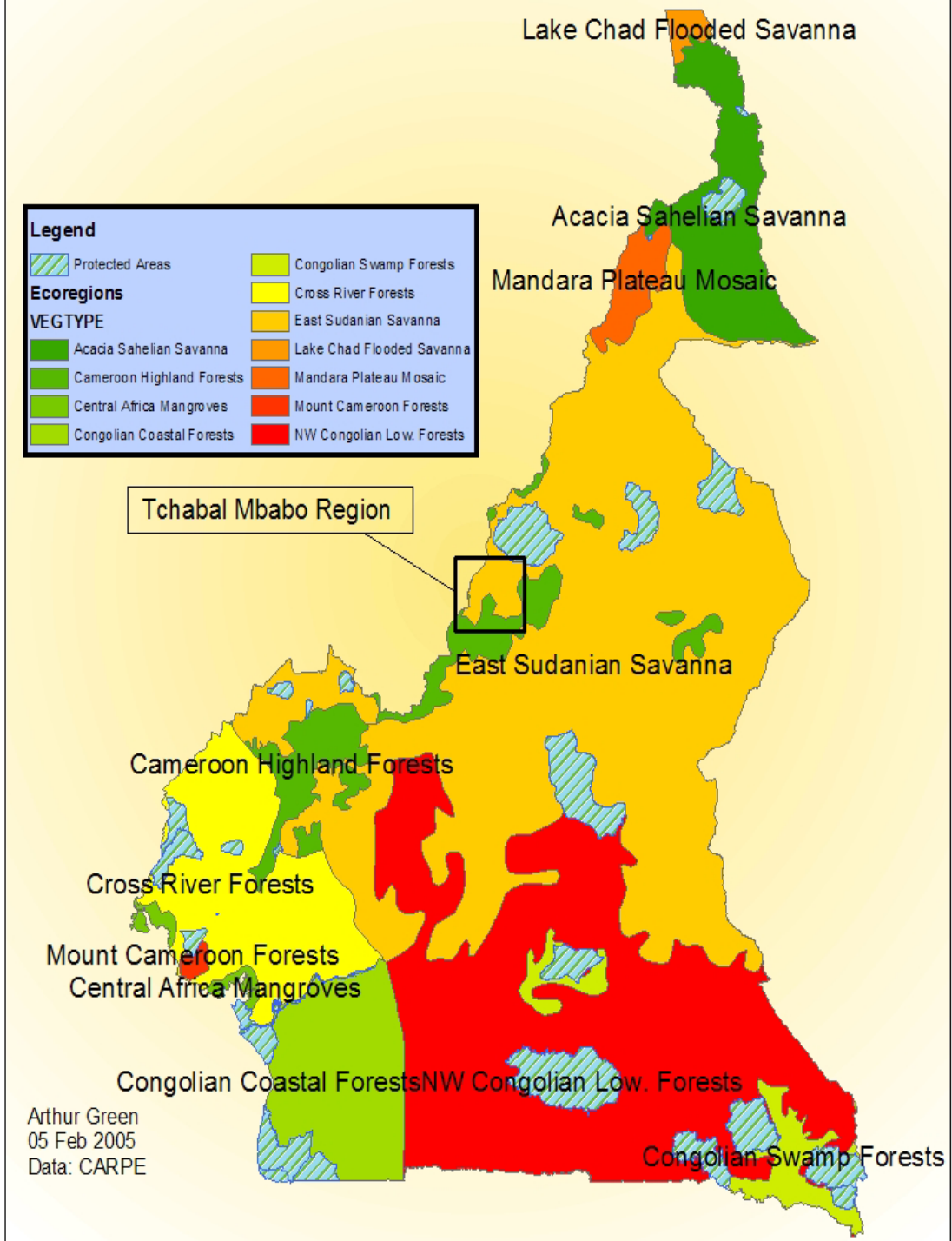


Figure 1.10: Map of Cameroon's Protected Areas by Ecoregion

Managing such an amount of land in a diversity of ecosystems requires a great amount of technical expertise. Yet, to further complicate this problem, the diversity of ecologies in this country is matched by an equally diverse demography of more than 250 officially recognized ethnicities (and languages) and 7-9 million rural citizens (49% of the total population) (PDDESA-UN 2004; U.S. Department of State 2005). These conditions are bound to render management complex and tenuous under the best of circumstances and they require the presence of properly trained professionals not limited to foresters, sociologists, economists, and ecologists. However, a recent study by the Temu *et al.* (2005) finds that there is a severe dearth of technical expertise in the region and no prospects for change in the foreseeable future. Difficult obstacles confront projects that wish to comply with the NEMP, not the least of which is identifying and maintaining relations with stakeholder groups.

Some of the most difficult stakeholder groups to identify and work with are pastoral and agropastoral communities (Iro 2005; Boyd *et al.* 1999). In bucolic Northern Cameroon¹³, development projects and conservation areas have long been challenged by work with agropastoral communities (Dunn *et al.* 2000; Bello 2004; Njiforti & Tchamba 1993; Scholte *et al.* 1999; Hall & Blench 1997; Weladji 2003; Kouokam & Ngantou 2003). Pastoralists and agropastoralists pose a unique set of challenges to ICDP administrators. Among these challenges are the following:

- Communities are difficult to maintain contact with because they are often remotely located or itinerant (Iro 2005). Time and money are formidable constraints to continued interaction between agropastoralists and project administrators.
- Communities in this region are often extremely insular and distrust secular government (Lacroix 1952; Boutrais 1995; Virtanen 2003; Green & Tchinelé 2004; Tiayon 2004).
- There is an historical antagonism between pastoral groups and conservation initiatives that have focused on hunting reserves and conserving large mammals in direct affront to the traditional land management of practices agropastoral communities (Bello 2004;

¹³ Northern Cameroon is a term that predates current administrative divisions and is commonly used to refer to the three most northern provinces: Adamaoua, le Nord, and L'Extreme Nord.

- GEF 2001; Njiforti & Tchamba 1993; Scholte *et al.* 1999; Hall & Blench 1997; Weladji 2003; Kouokam & Ngantou 2003).¹⁴
- Limited access to research and lack of knowledge of specific agropastoral groups leads people to extrapolate anecdotal and stereotypical behaviors between groups.
 - To the casual observer the complex political structures and ramified ethnic lineages of agropastoral communities (specifically the Fulbe of Northern Cameroon) can easily be overwhelming or simply overlooked and encourage people to assume that the groups are homogeneous or acephalous.
 - Sometimes representatives of the groups are not appropriate. Fulbe based in cities cannot truly represent the interests of rural groups. As well, the complex traditional political structure of *lamibé* (chiefs), who are taken to represent the pastoralists, is quite often misleading and not even traditional.¹⁵
 - There is a common understanding among conservationists that agropastoralists degrade rangelands and are to be avoided at all costs. Rangeland science has only recently begun to critically research assumptions about the damage that agropastoral communities cause on the specific vegetation types in the Sudano-Guinean Savanna and Sahel ecologies. So despite a growing recognition of the utility of traditional cattle husbandry methods, the common perception of agropastoralists as antithesis to conservation persists (Iro 2005; Niamir-Fuller 1999; Turner 1999).

GGTM is confronted with many of the above obstacles as it tries to identify and disaggregate stakeholder groups in order to implement its participatory initiative (GEF 2001; Bekker 2004).

The project has not been able to disaggregate stakeholder groups into policy and extension relevant user groups for the above reasons (GEF 2001; Bekker 2004; Green & Tchinké 2004). Emic ethnic categories may be able to facilitate this process of disaggregation of broad stakeholder categories into user groups.

¹⁴ “Agropastoralists in West Africa have usually been excluded from protected area use and management; thus a level of distrust still exists. Securing support of the Fulani and other communities at TM (*Tchabal Mbabo*) will require a sensitive and careful period of dialogue, information and negotiation if it is to be successful.” (BLI GEF Proposal 2001) (Italics added)

¹⁵ The agropastoral Djafoun Mbororo of Tchabal Mbabo had little political power under the abusive tax relationships with the Lamido of Tignère (Huya Fulbe) and the Lamido of Galim (ethnic Nizaa or NyamNyam) who were given political advantages by French colonial administrators after they took over Cameroon in 1919 from the German colonial administration. The pastoral populations are often not represented through what seems to be traditional authority but is in reality an artificial political appointee of the current national power.

1.5 Ethnicity and Natural Resource Management

1.5.1 A Global View

As noted above, the general and persistent connection between ethnicity and behaviors involved with natural resource management is widely recognized in academic fields and in the applied development field (Niamir-Fuller & Turner 1999; Harris 1966; Moran 1979; Salzman & Attwood 1996; Seymour & Smith 1986; Salamon 1992; Woodhouse 2002). In Africa the connection between ethnicity, livelihood, and NRM behavior is largely due to specialization of labor in the traditional economies (Reader 1998). This rational specialization of groups into communities mainly dedicated to pastoralism, fishing, hunting/gathering, or agriculture is a factor of labor and resource availability (Niamir-Fuller 1999; Bonkoungou 2001; McCarthy 2004; Comaroff 1987; Turner 1999). For example, pastoralism in Africa is mobile because it is designed around the ability to capitalize on sporadic growth in arid areas, to avoid disease vectors, and to move to the best dairy and beef markets (Niamir-Fuller 1999; McCarthy 2004; McCarthy *et al.* 2000; Iro 2005). Blench (1999) explains aspects of these characteristics:

Although in the popular imagination ‘nomads’ wander from place to place without any logic, their landscape is flecked with an invisible constellation of resources. Pastoralists have to balance their knowledge of pasture, rainfall, disease, political insecurity and national boundaries with access to markets and infrastructure. They prefer established migration routes and often develop long-standing exchange arrangements with farmers to make use of crop residues or to bring trade goods. Pastoralists usually only diverge from their existing patterns in the face of a drought, a pasture failure or the spread of an epizootic. Nonetheless, this flexibility is often the key to their survival. Highly mobile camel people such as the Rashaida retained a much greater proportion of their herds than the neighbouring Beja in the droughts of the early 1980s because of the Beja attachment to set routes and pastures.

Cattle movement patterns and the knowledge and social capital passed on between generations begin to constitute shared value systems and group histories that define group, kinship, and ethnic boundaries (Niamir-Fuller & Turner 1999). For example, in the case of pastoralists, the selection of animal and cattle breeds is often thought to reflect more

comprehensive NRM strategies being employed by groups (Blench 1999; Bonkougou 2001; Kohler-Rollefson 2001). Indeed, in our study region all of the subethnic groups are intimately associated with traditional breeds that reflect the ecological limitations they must overcome and the cultural values of their communities (Blench 1985, 1999; Boutrais 1991, 1995).

Although strong connections between livelihoods, ethnicity, and NRM behaviors were evident in the past, dramatic changes in pastoral livelihood strategies question the current validity of this linkage. Pastoral societies are under a great amount of stress and their adaptations to these stress factors range from increasing extensive pastoral strategies to adopting more and more sedentary lifestyles (Boutrais 1995; Blench 1999; Fratkin 1997; Moritz 2003; Niamir-Fuller & Turner 1999).¹⁶ The adoption of sedentary lifestyles seems to be the primary strategy for most of the cattle raisers in the Sudano-Guinean regions, while in the driest areas of the Sahel more extensive pastoralism is the main adaptation to scarce resources. Fratkin (1997) states, "Pastoral societies face more threats to their way of life now than at any previous time. Population growth; loss of herding lands to private farms, ranches, game parks, and urban areas; increased commoditization of the livestock economy; out-migration by poor pastoralists; and periodic dislocations brought about by drought, famine, and civil war are increasing in pastoralists regions of the world." As pastoral societies adapt to these challenges, the theoretical approach to pastoral communities has changed, "in the last decades, African pastoral societies have undergone rapid and far-reaching changes: they have been progressively articulated within larger market economies and incorporated into states. It has thus become increasingly problematic to study pastoral societies as functional adaptations to ecology" (Moritz 2003). The process of adopting sedentary production systems and adapting traditional subsistence production to commercial demands involves changing NRM strategies that once promoted the continuation of

¹⁶ These sedentary lifestyles are not always agricultural. In the Mbororo community there are many who have gone become merchants and, in the Tchabal Mbabo area, sapphire dealers.

ethnic and subethnic groups as well as changes in the paradigms through which such dynamic communities should be researched and understood.

Recognizing these changes, many researchers insist that the definition and the study of “pastoralism” and the “ethnicity of pastoral groups” is now too narrow and attached to ideas of ecological adaptation. Authors argue for a broadening of the definition and study of pastoralism to include the spectrum of communities that no longer fit the narrow academic definition of pastoralism, but who are now agropastoralists (Moritz 2003; Anderson and Broch-Due 1999; Fratkin 1997; Little 1992). Some researchers identify closely with a definition of pastoralism proposed by Chang and Koster (1994), “that keeping herd animals requires human beings to shape their lives- socially, culturally, economically, and ideologically- in ways that are structured by interdependence with their animals. The husbandry of animals represents a commitment to a way of life.” This definition is broad enough to include the spectrum of agricultural adaptation that pastoral communities are pursuing in order to survive, while excluding groups of agriculturalists who happen to own cows which pasture around villages.

Along with redefining pastoralism, many scholars see the pastoralists’ integration into sedentary communities and the disappearance of purely pastoral NRM behaviors as the beginning of the end for some pastoral subethnic and ethnic groups (Moritz 2003; Frantz 1981). However, even as groups settle down and adopt levels of agropastoralism, other authors continue to see the relevance of these subethnic groups in spheres of NRM behavior, marriage patterns, language, genetics, and other criteria (Virtanen 2003; Guichard 2001; Boutrais 1991, 1995, 1999). As pastoralism is redefined and behaviors change, we should question the relevance of ethnicity to NRM strategies. We must understand how adaptations of *indigenous technical knowledge* (ITK) systems to new realities are intertwined with ethnic identity and whether paradigms that support use of ethnic

categories and local political structures can be relied upon in the context of participatory conservation and development programs.

1.5.2 In the Local Context

Each of the broad livelihood categories listed above (pastoralism, agriculture, fishing, and hunting/gathering) include many ethnicities that do not pursue exactly the same NRM strategies to guarantee their livelihood. As well, among ethnic groups in each category, the purity of specialization is subject to change according to many variables. Operative ecologies, social constraints, and group histories differ for ethnicities that practice the same broad category of livelihood strategy even within the same region. For example, ethnicities that practice pastoralism do share many features in common, but should not be considered to have homogenous NRM strategies even within the relatively small geographic region between the Adamaoua Plateau and Lake Chad (Galaty & Salzman 1981; Moritz 2003). Recent research on the agropastoral populations surrounding the Tchabal Mbabo region shows that the adoption of insecticide and insecticide application methods on cattle is related to ethnicity (Boutrais 1991). Research on the region since the 1970's has found significant differences in choice of settlement elevation and cattle breeds (Blench 1985, 1999; Green & Tchinné 2004; Boutrais 1991, 1995). There is reason to believe that subethnic identities do still play a role in orienting NRM choices (Blench 1985, 1999; Boutrais 1991, 1995; Green & Tchinné 2004). For a better understanding, we can explore the relationship of cattle breed to subethnic groups.

Although there is presently a considerable amount of mixture among individual herds, each of the subethnic groups in this region originally had a specific breed of cow

associated with it. The particular breed of cow that a subethnic group uses reflects the unique historical migrations, ecological hurdles, and cultural ideals that cattle owners pursued in their breeding programs (Rege 2003; Blench 1999; Bonkougou 2001). According to Bonkougou (2001), “Traditional herders use a wide range of selection criteria to promote biodiversity in family herds. The most widely used criteria include: desirable reproductive characteristics, resistance to drought and disease, adaptation to conditions such as temperature, insolation, precipitation and mineral resources.”

Table 1.4. Subethnic Groups and Cattle Breeds (Blench 1999)

<i>Subethnic Group</i>	<i>Cattle Breeds with Alternative Names (Blench 1999)</i>
Huya FulBe	<i>Gudali, Wakwa, Ma'Ineeji, European breeds</i>
Djafoun Mbororo	<i>Bodeeji (Rahqi, Red Bororo, Abore, WoDaaBe)</i>
Aku Mbororo	<i>Daneeji (Yakanaaji, Akuji, Bunaji, White Fulani)</i>

On Tchabal Mbabo we see these criteria reflected in the subethnic groups breeds. The Djafoun are known by their *Bodeeji* breed of red cows with giant horns. The association of the Djafoun with this breed is indicated even in colonial correspondence (Boutrais 1999). The red cows that the Djafoun use contrast to those mainly used by the Aku Mbororo, white cows called *Daneeji* or *Akuji*. Breeds common among the Huya FulBe- the *Gudali, Wakwa, Ma'Ineeji*, and some imported European breeds- are different again from the Aku and Djafoun. Each one of these breeds is specially adapted to its

certain ecological environment and intimately associated (as one can see by the alternative names in *Table 1.3*) with their subethnic groups. The cattle breed reflect community goals such as milk or meat productivity, type of vegetation eaten, distance able to walk between waterings, horn size, resistance to disease (i.e. trypanosomiasis), ability to fight predators, temperament, and many other variables (Dupire 1954; Rege 2003; Blench 1999). As well as ecology and economy, cultural values also play a role. A concrete example of this is that, the Djafoun's adoption of the *Bodeeji* was related to the prestige associated with the breed's specialization in grass, their aesthetic value, and the reputed higher quality beef (Blench 1985, 1999). The *Daneeji* breed used by the Aku, who spent more time in lowland areas, is a sturdier and more adaptable breed that can survive on browse, milks well, can endure drought, and often is a much heavier, opportunistic grazer than the *Bodeeji*. Adoption of the *Daneeji* is a strategy intimately associated with drier areas of the Sahel where grass production is sporadic and cattle must take advantage of the browse in order to survive droughts (Blench 1999). These breeds have many other differences between them like the *Bodeeji*'s ability to fight off predators with its long horns and the *Daneeji*'s ability to grow quickly in the early years to quickly reproduce and provide milk (income and food for pastoralists). The Huya Fulße breeds are typically rapid beef producers that cannot browse well and have less disease resistance than the indigenous breeds. Most of the breeds in use by the Huya are crossbreeds of indigenous and nonnative cows, thus requiring access to veterinary facilities that are sometimes rare in the bush (Boutrais 1991; Blench 1999; Mason 2002). Cattle breed also signifies differences in social structures, such as gender empowerment. Among the Aku, women are thought to play a stronger role in family decisions due to their unique responsibility for income from milking the cows and selling dairy products

in villages. Among the more Islamized Djafoun and Huya patriarchy women are less empowered, beef production is more central to the livelihood strategy and women do not account for any significant income for market transactions, nor is it even appropriate for them to go to markets alone. Cattle breed is one variable that makes an intimate link between subethnic groups and NRM strategies and reflects the entire socioeconomic and cultural life of its owners.

Indeed, proof of such relationships verifies perspectives that continue to disaggregate the Aku Mbororo, Djafoun Mbororo, and Huya Fulbe agropastoralists and support the idea that subethnic categories are an important factor in developing extension approaches. The application of such an approach may help GGTM to develop more efficient approaches to grazing rights and management of breeding programs that benefit the local communities while meeting their desires.

1.6 Regional History

An understanding of the regional history of this area is essential in understanding how migration patterns, ecology, and other factors played a role in the fragmentation of the Fulbe subethnic groups and exploration of their NRM strategies. Mohammadou (1981), Boutrais (1995), and Virtanen (2003) approach the regional history through a chronological recounting of each subethnic group's migration. This approach easily frames the regional evolution of subethnic identities, so this section on regional history follows this approach by introducing first the Huya Fulbe, then the Djafoun Mbororo, and finally the Aku Mbororo. Each subethnic group is composed of lineages. These lineages play an important role in the social organization of the Fulbe diaspora. *Figure 1.11 Fulbe Diaspora on Tchabal Mbabo* graphically explains the structure of the lineages of each subethnic group.

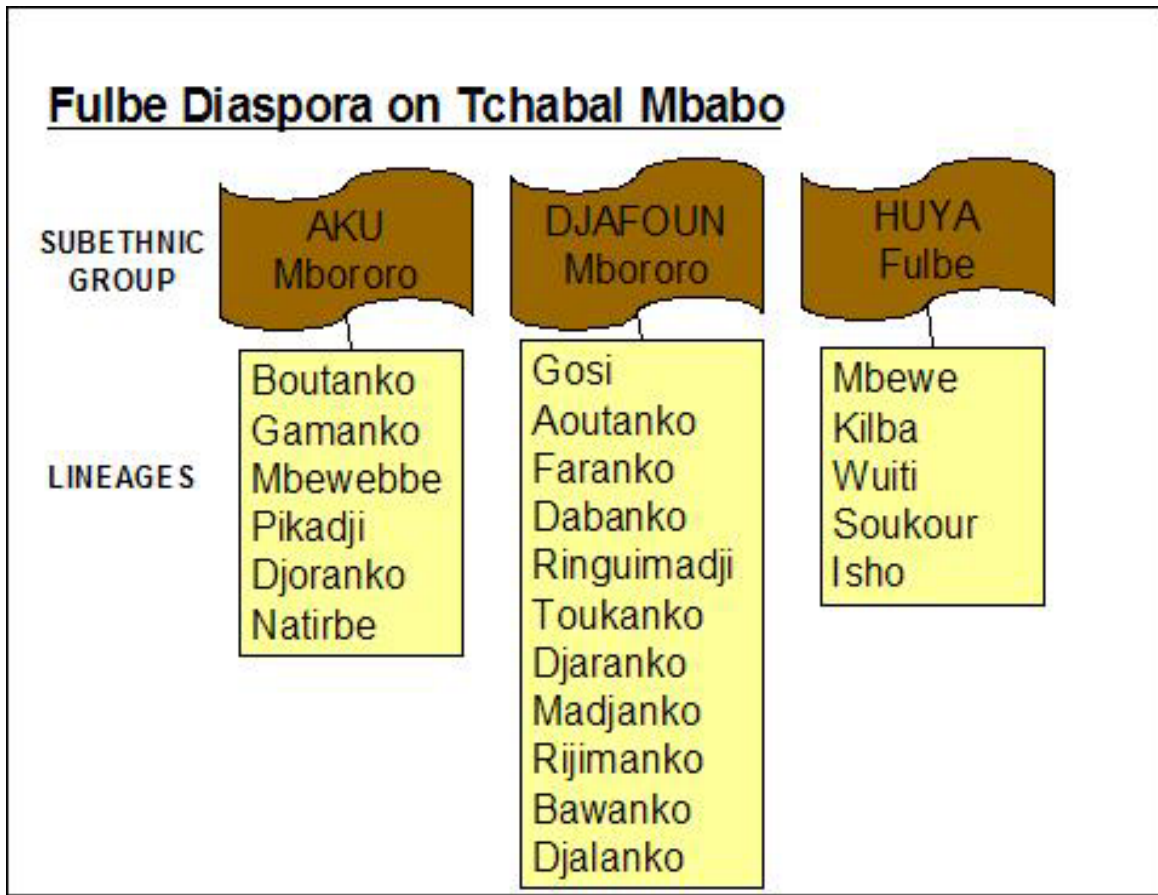


Figure1.11 Fulbe Diaspora on Tchabal Mbabo

However, before explaining the migration history of the different subethnic groups, it will be of benefit to offer a quick overview of this region's complex colonial history. The Tchabal Mbabo region is split between the traditional chiefs (*lamibé*) of Banyo, Dodeo, Galim, and Tignère. This region is within 30 km of the Nigerian border. The region has been exchanged many times by colonial administrations. Although the Fulbe are considered by many to be the first colonizers of this region's indigenous populations, Cameroon's (Kamerun) first European colonizers were the Germans who arrived in the Adamaoua region in the early 1900's. The Germans lost Cameroon during World War I, the region passing to French and British colonial administrations in 1919. With disrespect to cultural or ecological boundaries, the border between English run Nigeria and French run Cameroon (Cameroun), split the highlands and the

traditional lands of the lamidates of Dodeo and Banyo and caused complex local political struggles. By the 1950's Cameroon was still run by the French, but considered to be a charge of the United Nations. Cameroon achieved independence from colonial rule in 1960-61. It has, since then, been run by a small circle of Cameroonian elites. The first leader of the country, El Hajj Ahmadou Ahidjo, came from the North Province, but attempted to balance his cabinet with representatives of Cameroon's diverse ethnic mix by allocating positions of power to men from all regions of the new country. Ahidjo's successor, Paul Biya, has ruled the country since he took control of power in the early 1980s. Since Paul Biya, a southerner, took power, development of the Northern provinces has suffered greatly. Thus, places like Tchabal Mbabo and Dodeo have remained isolated and undeveloped, while at the same time being socioeconomically influenced by laws made by many foreign administrations.

1.6.1 Huya Fulße

During the period between the 13th and the 16th centuries an important process was occurring in the Sokoto area of northern Nigeria that would eventually lay the groundwork for social hierarchies in the Adamaoua region and around Tchabal Mbabo. Some of the nomadic, pastoral Fulße communities that had migrated around Sokoto and Kano started to integrate into the dominant, sedentary Hausa culture (Hennig 1993). The urban centers of the Hausa community were trading hubs where Islam and commerce went hand-in-hand. The conversion to Islam and adoption of more sedentary lifestyles that were quite different from the nomadic way of life was part of a general trend of pastoralists in West Africa (Moritz 2003). These changes initiated a deep fragmentation of the eastern Fulße society into pastoral and village based groups. The pastoral groups became known as the Mbororo (*Fulße ladde* or Bush Fulße) and the more urban, Islamized groups became known as the Huya Fulße (*Fulße nuro* or Village Fulße) (Guichard

2005; Mohammadou 1981; Virtanen 2003). The original rural-urban, pastoral-agrarian, pagan-Muslim differences between the Mbororo and Huya Fulbe (*Huya'en*) come from this period and have been reinforced over the years. Virtanen (2003) even found that the Mbororo and Fulbe in this region had embraced different versions of creation stories that emphasized the value of being Muslim (Huya) or honorable and part of the pastoral tradition (Mbororo). These original dichotomies have started to fade away; Huya Fulbe are now moving to live in rural areas and some Mbororo are moving to cities or adopting agriculture. Yet these subethnic categories remain very valid and mutually exclusive (Guichard 2005). In other words, the historical difference in livelihood modes has started to fade away; nevertheless, it is leaving very disparate ethnic identities divided by different sets of cultural norms, mores, and ideals and still marked by natural resource management strategies which evolved in relation to past livelihood choices (Boutrais 1991, 1995; Virtanen 2003).

Despite the earlier use of the term to explain a rural-urban dichotomy, the term “Huya Fulbe” now constitutes a truly unique subethnic group. Studies have found that the Huya Fulbe subethnic group is very elastic in that it encompasses many Fulbe clans¹⁷ and has assimilated many non-Fulbe groups (Spedini *et al.* 1999). However, despite the fact that it has integrated many other communities, the Huya Fulbe remains mutually exclusive to the Mbororo subethnic groups. The Mbororo actually are fragmented into three subethnic groups, all of which are quite endogamous. One of the main reasons that the Huya Fulbe are genetically and culturally closer to many of the agricultural groups than the Mbororo is because the Huya Fulbe deviated from the Mbororo in marriage practices thanks in part to their more thorough adoption of Islam and

¹⁷ Depending on the author the terms subethnicity, clan, lineage, and family can mean very different things. For the purpose of this project, these terms represent a hierarchy that signifies from top to bottom: subethnicity to lineage to family. *Subethnicity* is used to represent the Huya Fulbe, Aku Mbororo, and Djafoun Mbororo divisions. I will use the term *lineage* (though *clan* is interchangeably used by other authors) to represent groups within the subethnicities. The term *family* is used exclusively to describe a nuclear unit of people, though that may have polygamous relations.

their use of slaves. The Huya Fulbe accepted exogamy, while the Mbororo practice endogamy based on lineages up until this very day.¹⁸ The Mbororo maintained strict rules for marrying inside their subethnic group (and even lineages) resulting in very little genetic heterogeneity or cultural variation. This acceptance of exogamy played an important role in the development of the Huya Fulbe in two specific ways. It allowed them to be assimilated and Islamized into the dominant Hausa society in Northern Nigeria, and then to assimilate many other ethnic groups in Northern Cameroon where the Huya became the dominant culture in the post-jihad period of the 19th century (Guichard 2005; Spedini *et al.* 1999). Marriage practices played a crucial role in intensifying the fragmentation of subethnic groups that had originally deviated in livelihood practices and religious affiliation. These marriage patterns also played a role in the further fragmentation of the Mbororo into three more subethnic groups (the Djafoun, Aku, and Wodaabé subethnicities).¹⁹

The migration patterns of the multiple Mbororo and Huya Fulbe subethnicities to the Adamaoua region reflect the original urban-rural dichotomy and help explain some of the significant genetic and cultural deviation that later evolved. In Sokoto and Kano (sometimes called *Hausaland*) the Huya Fulbe had learned the rites of Sufi Islam sects. In Hausaland they were novices, but by the time they reached the Adamaoua in the 1700's the ethnic identity of the Huya Fulbe was intimately associated with Islam. The Huya Fulbe, with the one notable exception of the Wolarbé²⁰ lineage (clan), migrated between cities as sedentary groups. Though

¹⁸ For example, the Gosi lineage of Djafoun Mbororo marry primarily with other Gosi; usually first and second cousins. Unfortunately, these marriage practices also led to Huya Fulbe sometimes disparagingly referring to the Mbororo as incestuous and uneducated people.

¹⁹ The Wodaabé Mbororo are not present in the study area, so they do not form a part of this study. They are considered to be the most nomadic of all the Fulbe and they remain the farthest north of all the subethnic groups (remaining in the regions that regularly have less than 500mm of rain). They prefer to remain distant from and independent of other Mbororo (or any Fulbe) subethnicities. They avoided this region because the Djafoun and Huya effectively controlled the pastures in the post jihad period, thus eliminating opportunity for the Wodaabé.

²⁰ The Fulbe clans in the Adamaoua area include the: *Wolarbé, Feroobé, Ba, Toroodbé* and *Yirlaabé*. Among the many clans that now constitute the Huya Fulbe, the dominant clan around Tchabal Mbabo and in the Adamaoua region is

they continued to raise cattle as they moved to Garoua, Ngaoundéré, and farther south to Tibati and Banyo they were not pastoralists in the strict sense of the word. They were people practicing a mix of agriculture, animal husbandry, trade, and religious professions. Cattle were still seen as the major stock of wealth. Limitations to cattle wealth imposed by tsetse flies²¹ discouraged pastoralists from extending the southern limit of their range further into the Adamaoua, which was then known as *Fombina*.²² Though these Fulbe first came to the Adamaoua as relatively peaceful agropastoralists, teachers, and traders, they soon became conquerors due to revolutionary winds from Sokoto.

In 1805 the Fulbe, Muslim intellectual Shaikh²³ Usman dan Fodio denounced Hausa rule and soon after declared a jihad to, ostensibly, purify the Islamic community of pagan rituals. The jihad went beyond subethnic differences and religious proclamations; it encapsulated a new type of political authority that would last until the European colonial armies would change the political landscape of the Western Sudan. In reality, the Fulbe community felt aggrieved by the Hausa rulers, and their socioeconomic and political frustration manifested as a holy war. Religiously, a full turn of the tables had taken place with the Fulbe now identifying themselves as the true inheritors of the Muslim faith.²⁴ There still was a divide between pastoral Mbororo groups that were not as Islamized as the Muslim Fulbe leaders based in urban areas. Many pastoral groups did not fully participate in the jihad. Despite this, other pastoralists, though only nominally Muslim, participated in the jihad as it offered them a way to escape what they felt was

the Wolarbé. The Wolarbé, interestingly, did not become sedentary (and meet the official definition of Huya Fulbe) until the post jihad period in the early 1800's (Virtanen 2003; Mohammadou 1981).

²¹ Tsetse flies (*Glossina sp.*) spread trypanosomiasis which can devastate cattle herds.

²² *Fombina* means south in Fulfuldé. Fulfuldé is the language spoken by Fulbe people and the local lingua franca in septentrional Cameroon.

²³ Also spelled Sheikh, this term refers to an elder or religious leader.

²⁴ Interestingly, part of the success of the jihad and the unity among the Fulbe was because many thought that Usman dan Fodio was the coming *Mahdi* (Hennig 1993): "Even if the entire duration of the world's existence has already been exhausted and only one day is left before Doomsday (Day of judgment), Allah will expand that day to such a length of time, as to accommodate the kingdom of a person out of my Ahlul-Bayt who will be called by my name. He will then fill out the earth with peace and justice as it will have been full of injustice and tyranny before then." (Sahih Tirmidhi, V2, P86, V9, P74-75).

unreasonable taxation by non-Fulbe ethnicities and to extend pastures. By 1810 the Fulbe cavalry had secured Hausaland (Northern Nigeria) and established the Caliphate of Sokoto. Now attention turned to the border regions where fighting with *kirdi* (the Fulfuldé term meaning “pagan”) populations was experiencing some success and expansion was moving rapidly thanks to advantages that Fulbe cavalry had over these people without horses (Hennig 1993). Hennig (ibid) briefly retells the conquest of Fombina.²⁵

As early as one year after the appeal of holy war by dan Fodio, in 1805, the mobido Adama of the Ba-clan received the white flag of the jihad, and the title as chief of command against the Kirdi in Fombina. Adama thus received the title of "Lamido Fombina" or emir, as he normally is called in European literature. He established his headquarters in Gurin by the River Faro, but later moved it to Yola by the River Benue in 1841. "Fombina" later became known as Adamawa, named after its founder Adama...

Between 1810 and 1830, the Fulbe started their military expeditions south of the Benue. Their push towards the south was part of a new stream of migration of Fulbesouthwards, causing other peoples to move southwards and thus having effects all the way into the southern rainforests. Between 1825 and 1845, Fulbeof the Wollarbe clan conquered the southern Adamawa plateau and founded the great lamidates of Ngaoundéré, Tibati and Banyo. Here, the Fulbewere met by the relatively highly organized Kirdi peoples Duru, Mbum, Gbaya and Vute. Giving resistance to the Fulbe invasion, they however got subjugated to Fulbe rule in short time. The efficiency of the Fulbe cavalry in this well suited terrains is seen as the principal military explanation of these easy military victories. About 1850, the conquest of Adamawa in general was fulfilled, with some 40 established lamidates and most of the indigenous population subdued Fulbe rule or living as refugees in marginalized areas. In South Adamawa, the expansion continued as slave hunting campaigns. Thus, the jihad had started as a rebellion in the north, but had continued as mere conquest of new territories in the south, further perverting into slave hunting campaigns. (*lamidate*= region under the control of a chief, much like a fiefdom)

Consequently, slave raiding and ivory trading became major income sources for the Huya Fulbe located throughout the region, especially in Tibati where cattle raising was the most difficult due to disease vectors. The slave raiding made many Huya Fulbe rich and it supported a new social

²⁵ Spelling is not often harmonized in this region. Hennig (1993) using the “Adamawa” spelling more common in Nigeria, whereas “Adamaoua” is the Cameroonian version. Moreover, *Mbum* are known as Mboum, *Vute* are Vouté, *Duru* are Nduru, and so on.

hierarchy that found its ideal in the *lamido* (chief) as the image of a pious, Fulbe patriarch. The early assimilation of local people often occurred as part of the slave trade and Islam. Per their tradition, a slave could be released when she/he converted to Islam. These released slaves were considered to be on the road to Fulbe-ization and were capable of being married into Fulbe lineages. The resulting children of these marriages, and consort relationships, came to constitute the definitive Huya Fulbe subethnic group (Spedini *et al.* 1999).²⁶ However, despite the intermarriages, remnants of the bonds of servitude and this social hierarchy exist even in the modern day relationships between “pure Fulbe” and the mixed populations; Spedini *et al.* (1999) found that it took three generations before assimilation was complete.

Before the jihad there were scattered minorities of Fulbe pastoralists in the region, but the post-jihad period saw the first true mass migration of Fulbe into the region. Because the Mbororo of Tchabal Mbabo did not play a role in this migration or the local jihad, they currently use the “Huya Fulbe” term to recognize the entirety of non-Mbororo Fulbe in the region. Indeed some Mbororo question the Fulbe-ness²⁷ of the sedentary Huya and call themselves “true Fulbe.” The opposite is true of the Huya Fulbe who often question the piousness and, therefore, Fulbe-ness of the Mbororo. The cultural ideals of these subethnic groups have changed. The cult of the cow has intermingled with that of Islam, and to varying degrees the current activities of each subethnic group are reflected in their idea of being Fulbe. Virtanen (2003) recorded the following statement by an old Mbororo man reflecting on the differences of modern life in Cameroon with the Huya Fulbe after migrating from northern Nigeria:

²⁶ The Huya Fulbe recognize that their blood lines are mixed, thus there is still some social utility out of being able to claim a purer lineage to a Fulbe clan. I had numerous occasions when non-Mbororo Fulbe would claim to be of the *Wolarbé* lineage, sometime mentioning that one of their parents was “pure-blooded Fulbe.”

²⁷ For the Mbororo the true nature of Fulbe-ness is within the social ideals of *pulaaku*, *haakilo*, and ownership of cattle; for the Huya Fulbe-ness is more based on the ideals of piety and Islam (Virtanen 2003).

All of us, Fulbe (= pastoral Fulbe, Mbororo), followed our own relatives. We followed our own people, a big ardo (Mbororo chief). We did not follow the Huya (the village Fulbe). But now in their own land, we have to follow, haven't we? Didn't we come into their land? (sic)²⁸

The Huya Fulbe centralized power and setup the largest organized empire in the region through their system of *lamidates* run by *lamibé* (chiefs).²⁹ These lamidates officially fell under the Sokoto Caliphate, but were known to be the most rebellious and independent from the caliphate in the entire region. The lamidates combined socioeconomic power with a religious hierarchy that posed the lamibé as the leading Muslims in their community. The political structure became inextricably tied to being Muslim. The main Mbororo migrations followed the Huya settlement of the Adamaoua, so the lamidates created by the jihad were not representative of the Mbororo. In fact the sedentary lamibé often exerted heavy cattle taxes on migrating Mbororo (Boutrais 1999).³⁰ Perhaps unsurprisingly, this political structure drove an additional political and cultural wedge between the Huya Fulbe and the Mbororo subgroups. Despite the conflicts, in some of the most southern lamidates initially there were friendly environments for the Mbororo largely because without them the Huya Fulbe had little access to cattle (Boutrais 1999).

The Mbororo, of course, feel somewhat indignant about the powerful lamibé system controlled by the Huya Fulbe up until this day. The one exception to the Mbororo isolation from the political structure was the Lamidate of Lompta. The Lamidate of Lompta covered the Tchabal Mbabo region and, unlike any other lamidate before or since, was led by the Djafoun Mbororo. This lamidate was created by the Germans during their brief colonial rule (1884-1918)

²⁸ An *ardo* is literally a “leader” and is the traditional way in which pastoral Fulbe lineages organized their groups under capable leadership.

²⁹ *Lamibé* is the plural of *Lamido* which means “chief.” A *lamidate* is the physical and geographic location of the chief's power.

³⁰ The Djafoun originally settled in areas near Tignère only to have the issue of taxation drive them from pursuing full relations with the Lamido there into a more open and lucrative relationship with the Lamido of Tibati (Boutrais 1999). The Lamido of Galim was recently reported to the government officials for what the Mbororo feel are extraordinarily heavy taxation practices on them.

and granted to the Djafoun. The Djafoun were in a continual state of guerilla warfare with the local Nizaa³¹ over cattle access to a mineral spring *laoré* located near modern Galim. Mineral springs are important sources of essential salts for cattle raising. The Germans sided with the pastoralists against the Nizaa because the Germans were partial to developing cattle as the most profitable industry in the Adamaoua.³² However, when the French took the colony in 1919, they created the Lamidate of Galim under the Nizaa in order to supplant Lompta and punish the Mbororo who supported the Germans' presence (Boutrais 1995).³³ Although the Djafoun Mbororo still pay reverence to their Lamido, the authority and relevance of Lompta were destroyed by the French creation of the Nizaa Lamidate of Galim. Although, in probably one of the strangest political arrangements in the Adamaoua, the Lompta lamidate never disappeared; it exists only as a shadow of its former charter, a landless lamidate with little ability to redress wrongs against its Mbororo subjects who have now spread throughout grasslands in the Adamaoua Province, the Northwest Province, the Central African Republic, and Nigeria. The Huya lamibé and colonial governance crippled the Mbororo ability to raise cows by subjugating them to taxation and limitations by agricultural communities. This has lent to the historical feeling of distrust between the Mbororo and Huya in this region and further entrenched the subethnicities.³⁴

³¹ The Nizaa are a Bantoid branch of the Benoué-Congo subfamily of the Niger-Congo language family. Fulfuldé (spoken by the Fulbe and sometimes called Fula) is part of the Atlantic branch of the Niger-Congo family.

³² The Germans improved the mineral spring by installing a pump and watering cement troughs for the cattle at the turn of the 20th century. After the Nizaa were granted ownership of the mineral spring it fell into disrepair even while the Lamido of Galim continued to charge herders fees to access the water which now puddles around the ancient pump house.

³³ Ironically, although this is a Nizaa Lamido created by colonial power, *Fulfulde* is the operating language of the lamidate of Galim and there are many Fulbe wives in his household. The Lamidate of Galim is effectively integrated into the Huya Fulbe power structure.

³⁴ It is a long standing tradition in the Tchabal Mbabo area to not reveal how many cows your family owns for fear of taxation. This vexes government officials to this very day (LaCroix 1952; MINEPIA 2004).

The Huya Fulbe presence on the plateau is largely due to the activities of Muslim teachers (Huya Fulbe) who find a lucrative and ready audience³⁵ among the newly settled Mbororo and due to insects and diseases that decimated Fulbe cattle populations in the surrounding region in the 1930s (Banyo and Dodeo) and 1960s (Yola). In effect, the latter Fulbe movements are a second migration fueled by economic flight. Poorer and somewhat more rural lineages of Fulbe, such as the Wuiti (Wiiti), Soukou, Mbewe, Kilba, and Isho, came to live among Mbororo (who had already settled the plateau in the post-jihad period of the late 1800s). These Fulbe lineages are sometimes called the Ma'Ine to differentiate them from the grand Fulbe lineages of the jihad. Despite this division, the Ma'Ine lineages were more integrated into the Huya subethnic group than the Mbororo.³⁶

The implantation of the Huya Fulbe and Aku Mbororo in Tchabal Mbabo is partially due to the historical animosity between the Djafoun Mbororo and the Lamidates of Tignère (Huya Fulbe), Banyo (Huya Fulbe), and Galim (Nizaa). These lamidates gave permission to Huya herders (as well as Aku Mbororo) to move up the sides of the plateau near Sambolabbo (Banyo), Galim, and Tignère in the 1970s. These events also coincided with the spraying of many of the streams on the southern side of the plateau with insecticide that killed tsetse flies and destroyed trypanosomiasis vectors. The newly cleaned pastures and friendly lamidates opened up the region to massive immigrations of both Aku Mbororo and Huya Fulbe. The new populations dramatically increased pasture demands and degradation, leading to a downward cycle of pasture availability around the plateau (Chapman 2004). As well, despite the massive insecticide spraying campaign, recurrent tsetse invasions limited the amount of pastures available to herders. These

³⁵ The newly converted Mbororo often don't trust themselves to conduct Islamic prayers and ceremonies and sometimes complain that they are not well-educated enough in these important matters so they must pay Huya.

³⁶ The Ma'Ine have spent more time in urban areas, are more Hausa-like, and more integrated into the Muslim hierarchy.

pressures on the pastoralists resulted in a gradual movement by the new agropastoralists to higher and better pastures where tensions between agropastoralists continue to increase.

The Huya were the first group from the Fulbe diaspora to truly settle in the Adamaoua. The subsequent migrations and settlement patterns of Mbororo and other Fulbe into the region were a result of this Huya presence. The early arrangements that were mutually beneficial for Djafoun Mbororo and Huya became difficult as political differences affected settlement and resource access. The ecological limitations of cattle raising, preoccupation with warfare, and the lucrative slave trade practiced by the Huya in the southern parts of Adamaoua insured a market for the cattle raised by the pastoralists in the highlands (Boutrais 1999). Moreover, the highlands' alluring ecological characteristics and Adamaoua's relative political stability were important factors in the Mbororo migration. However, the Huya isolated the Mbororo from political power due to their historical differences and the cultural spheres separating the urban-rural, sedentary-nomadic, and Islamic-pagan.³⁷ As mentioned above, the Lamidate of Lompta was the result of the German colonial presence, not filial affinity between the Fulbe subethnicities. Interestingly, the above dichotomies and issues of political power currently occur not only between the Mbororo and Huya, but also between previous and subsequent migrations of Mbororo creating the "temporal hierarchy" that Virtanen (2003) recognizes. The Huya migration and settlement history is integral to understanding how the Huya set the stage for the Aku and Djafoun Mbororo subethnicities to be part of the regional "temporal hierarchy" and how the subethnic groups' places in this hierarchy reflect their natural resource access and management strategies.

³⁷ The division between the Muslim and pagan now entails finer nuances. The Djafoun Mbororo are largely Muslim. However, in recent years a divide in the Muslim communities between the Sufi sects (becoming largely the Mbororo) and the Sunni reformers (largely the Huya) continues the alienation between the communities.

1.6.2 Djafoun Mbororo

The history of human settlement in the Tchabal Mbabo region is a complex arabesque of migrations that traditionally begins with the tale of the Nizaa (a.k.a. *Nyam-Nyam* or *Suga*) people who migrated from the Benoué River area to settle in the hill country south of the plateau. In fact, the highlands are surrounded by many different ethnicities of agriculturalists: Nizaa, Vouté, Tikar, Nduru, Koutin (or Peré), Mboum, Gbaya, Chamba, and others. Some argue that these groups of agriculturalists once practiced rudimentary forms of agriculture on the plateau. It is likely that they hunted on the plateau. However, the lack of climatically appropriate native cultivars coupled with a lack of strong archaeological evidence of settlement lends credence to theories that pastoral populations were the first to truly settle these highlands (Mohammadou 1981; Boutrais 1995; Virtanen 2003). The Huya Fulbe established their lamidates and when possible raised small numbers of cows close to the villages. It was not until the migration of the pastoral Mbororo began that Tchabal Mbabo was settled. Among the agriculturalists and Huya, the highlands were known as a cold, desolate, and unforgiving place. Yet, despite problems that early agriculturalists would have had settling there, the plateau offered many significant advantages for pastoralist who were used to living off the products of their herds. The Djafoun Mbororo, coming from an area named Jaafun in Nigeria, were the first to settle these large, open pastures in the highlands (Boutrais 1995; Virtanen 2003).

According to Virtanen (2003) it is usual to separate the arrival of three Mbororo groups that became part of a “temporal hierarchy” under the Huya Fulbe in the Adamaoua: the Djafoun, Aku, and Wodaabé. Here we are treating only the Djafoun migration; in the next section we will look more in-depth at the Aku migration. As mentioned above the Wodaabé are of regional significance, but of no importance to this study since they are not found in Tchabal Mbabo. Virtanen (2003) summarizes key historical points in the Djafoun migration:

The *Jaafun* and the *Aku* are part of a single migration story in which two main migration waves and several subwaves from Nigeria can be discerned... Both of the main migrations originated from Bauchi where a group of pastoral Fulbe, calling themselves *Jaafun*... arrived in the region from Kano before the *jihad*. The first wave from Bauchi started in the 1840s... About thirty years later they continued to Cameroon's Adamaoua where they moved between the territories of Banyo, Tibati, Tignère and Ngaoundéré for several decades. After that some of them moved westwards to the Bamenda Highlands while others headed for the east, reaching Meiganga and the present day Central African Republic by the 1930s. When talking of the migration of the *Jaafun*, we must pay attention to the fact that the group of people that the term *Jaafun* refers to has been historically transformed. Thus, while originally the *Jaafun* were known as a lineage that was named after a village east of Kano, later the term has become a more abstract, subethnic category. The change happened gradually as the *Jaafun* moved out of Kano and then from Bauchi and the term started to include more and more people from various lineages.

The Djafoun led the post-jihad migration into the Adamaoua region in the second half of the 19th century. Depending on the historian, their migration to the region occurred sometime between the 1840s and 1870s. There were many reasons that they came. In the Fulfuldé language the word *tchabal* means “plateau” and the word *mbabo* means “empty” or “no man” (Boutrais 1995). In recent years, the remote Tchabal Mbabo plateau has come to be known as “the last pastoral refuge” (Boutrais 1995). The abundant pasture and healthy atmosphere for cattle (lack of parasites and tsetse flies) have made these highlands a pastoral respite for communities that historically circumambulated the lowland savannas of northern regions of Cameroon and Nigeria (Mohammadou 1981; Mohammadou 2004). At the point of their migration, the Adamaoua was relatively politically stable, there was a giant demand in Tibati for cattle, and the highland ecology was superbly suited to pastoral interests whereas in regions to the north of the plateau the ecological vicissitudes and the continuing Fulbe jihad battles with the *kiridi* strongholds in Mandara (Wandala land) and other regions still plagued herding (Boutrais 1981).

As mentioned above, while the relationships between the Huya and the Djafoun were economically convenient and blessed by many ecological advantages, the Djafoun's

inability to access power and their abuse under the *Lamibé* system³⁸ led to a schism between the Djafoun and Huya. The later migrations of Fulbe and Aku Mbororo, sanctioned by the local lamidates, on the plateau sides and more and more frequently in higher elevations are a direct reflection of the Djafoun Mbororo and Huya Fulbe/Nizaa antagonism.

As mentioned above there are many characteristics, both behaviors and iconic symbols, which differentiate the Mbororo from the Huya Fulbe subethnic group. There are also many important characteristics that differentiate the Mbororo subethnic groups. Virtanen points to the Mbororo *soro*³⁹ ritual as one of the original, definitive characteristic of the Djafoun subethnic group. Yet, following what seems to be a general regional trend wherein pastoral communities adopt more sedentary lifestyles, become more Muslim, and progressively lose more of their original traditions the Djafoun no longer practice *soro* in this region. Huya Fulbe Islamic clergy preached against the Mbororo “forest games” (Moritz 2003). Ndoudi Oumarou, a nomadic Mbororo, stated “whenever a Koranic school opens, a little *soro* disappears” (Bocquené *et al.* 2002). Some Mbororo report the practice of *soro* among the Aku, Wodaabé, and among the less Islamized lineages that have wandered toward Bouar in the Central African Republic where the Huya Fulbe do not control the social hierarchy. Yet there are many other more practical things that still differentiate the Djafoun from the other subethnic groups- including dialect, dress, housing, the type of dairy products consumed, and livelihood choices (Boutrais 1991, 1995; Green & Tchinelé 2004; Tiayon 2004; Virtanen 2003).

³⁸ The Lamido of Galim, who at the time was not Muslim, made the herders pay a Muslim cattle tax as well as one head of cattle per herd to access the mineral springs. The Lamido of Banyo took Mbororo cattle hostage in a famous incident that almost started a tribal war, but instead resulted in the removal of a French colonial official. The Lamido of Tignère took the actual Mbororo chief hostage and held him ransom for 500 cows.

³⁹ *Soro* was a ritual wherein youths would gather and beat each other with a stick as a test of strength. This was a formative rite for the young men.

1.6.3 Aku Mbororo

The Aku Mbororo came in several migrations that are somewhat similar to the second migration wave of the Huya Fulbe. The Aku consider themselves people of highlands, although their collective recent experience is with more harsh environments to the north of the plateau and political conflict in the Mambila mountains area across the Nigerian border. The first Aku in the region came in the 1930s, but the Djafoun protests led the French administration to settle this first wave near Doulayel, 30-40 kilometers southwest of Tchabal Mbabo's southern gorges. However, the British colonial government's closing of the Mambila area in 1946 led to immediate waves of Aku Mbororo lineages to the Tignère area. The Boutanko lineage came in 1947 and the Gamanko lineage in 1950. The main three lineages of the Aku Mbororo on the Tchabal Mbabo are the Mbewebbe, Goutanko, and Boutanko. The Aku Mbororo are said to have migrated in jumps from the Jos Plateau, Mambila, Tchabal Kiri, and finally Tchabal Mbabo. Of course, it is no surprise that the Djafoun Mbororo were against these Aku migrations, but had little power to oppose them especially with the antagonism between the Djafoun and the Lamido of Tignère.

One of the most interesting economic results of the Aku Mbororo lineages installment in the area is the increased presence of dairy products in the markets. The Aku are less Islamized than the Djafoun and more willing to let their women go to markets to sell milk and other dairy products. Another interesting result was that the lack of an antagonistic history has led to amiable relationships between the Aku and the Huya Fulbe as well as local agricultural communities. Ironically, the friendship and increased economic contact between Aku Mbororo and agricultural communities around the plateau has also led to more farmer-herder conflict due to crop destruction.

The Aku Mbororo are less Islamized than the Djafoun, less sedentary (and quicker to emigrate), perhaps more oriented towards pure pastoral systems, and have the least amount of political influence of the agropastoral populations. Moreover, they engage in endogamy that limits their interactions with Huya and Djafoun subethnic groups. The Aku are perhaps the most liberal at breeding their cows of all the subethnic groups. Despite the durability of their traditional breed, the *Akuji* or *Danceji*, they see the *Goudali* as a better breed for the climate and the markets. Their ability to perform long transhumance and move quickly is changing due to this changing of breeds. There is a clear cultural and ethnic division between the Aku Mbororo and the other subethnic groups, but their NRM strategies may be adapting to the market conditions in the region.

The Aku Mbororo form the last group of migrants to the Tchabal Mbabo plateau. Their settlement pattern was geographically framed by the political tensions between the Huya and Djafoun. The Aku have settled mostly in the eastern areas of the plateau near Tignére and Galim. Many Mbororo and Huya Fulbe have remarked on the ability of their traditional breeds to take advantage of opportunistic vegetative growth. They say that the Aku breeds can eat more kinds of vegetation in a higher quantity than the other local cattle. For this reason, many think the Aku movements have led to the highest amount of ecological degradation, which is coincidentally found in the Galim and Tignére parts of the plateau. However, no study has ever systematically looked at the qualitative differences of resource use between the Huya Fulbe, Djafoun Mbororo, and Aku Mbororo and the connections between distribution of ecological degradation and the distribution of pastoralists.

CHAPTER 2: METHODOLOGY

2.1 Research Design

Data for this study were collected over a 20 month period from January 2003 to August 2004. Over this period, I used survey and participant observation methods to generate information on the NRM behaviors practiced by Akou Mbororo, Djafoun Mbororo, and Huya Fulße in the Tchabal Mbabo region. Screens were applied to select key variables from the survey for subsequent coding and non-parametric tests (Kruskal-Wallis and Pearson's chi-square) of differences in NRM behavior across groups. Participant observation was used to design an effective survey instrument, gather more descriptive data than a survey allows, and cross-check the survey results. Geographic data were collected during the survey and participant observation, as well as from satellite sources in the post fieldwork phase. In this chapter, I provide more detail on each type of data, including data collection and processing.

2.2 Survey Data

2.2.1 Survey Design and Implementation

A survey of 205 households was conducted January-April 2005 in collaboration with Bird Life International, MINEF, MINEPIA, local community members, and the University of Ngaoundéré.⁴⁰ The goal of the household survey was to collect data from agropastoralists across the plateau. Households were defined as nuclear family units. Head of households, usually the elder males, were interviewed.

The survey instrument was designed in Galim-Tignère and Mbabo villages in collaboration with representatives of the above groups. Since there was no access to printers or

⁴⁰ MINEPIA: *Ministère de l'Élevage, des Pêches et des Industries Animales*; MINEF: *Ministère de l'Eau et Forêts*.

copiers in these villages, a handwritten master and five handwritten copies were made by the collaborators. The survey instrument was designed to create a holistic picture of development possibilities in the region. It elicited information on demographics, community history, political and economic networks, and NRM behaviors. The survey questions were both closed-ended and open-ended. For the above reasons, information generated from the survey was copious and not limited to the scope of this study. Data relevant to this study was extracted through the content analysis and coding procedures described below.

Stratified sampling methods allowed the survey teams to capture a representative sample of the geographic distribution of agropastoral households around the plateau. Household surveys took place in three general areas: in population centers, in remote areas, and on transhumance trails. The survey teams identified the population centers as Mbabo, Mbontodjé I and Mbontodjé II, Mayo Kelélé, Dadawal/Fungoi, and Mayo Lelewal.

The term “population center” is used to differentiate the areas where housing is clustered from more remote areas, but “population centers” should not be considered as urban or periurban settings. Population centers include the two small villages (population ≤ 1000) of Mbabo and Mayo Kelélé, but most often these centers consisted of a loose grouping of ranches around a centrally located mosque. In the population centers, the survey teams attempted to conduct interviews at households within a 5km radius of the population centers.

The survey was implemented by 14 people in five teams. Each survey teams consisted of at least 3 members: a local *Fulfuldé* translator, survey director, and a French/English transcriber.⁴¹ Four teams worked in and around population centers. Three teams worked in the 5KM radius around population centers, and one team worked in the population centers. One team worked in more remote settings and on the transhumance routes. All team members were well acquainted

⁴¹ The author served on two separate teams: around population centers and on the transhumance routes.

with the survey since they played a role in its development. As well, they were given one day of training in how to impartially administer the survey and answer agropastoralists' questions.

The four teams that worked in and around population centers interviewed 176 households during January and February of 2005. These teams also conducted *Rapid Rural Appraisals* and held community meetings wherein agropastoralists were encouraged to ask questions about GGTM and how the project might affect their livelihoods. At the end of the day all teams came together, compiled surveys, and shared general thoughts and issues that had occurred during the day.

In the more remote areas and on the transhumance routes, only one team collected surveys. In addition to interviewing households, this team had as its central goal the mapping and observation of NRM behaviors on the transhumance routes. This team collected 29 surveys during the period of March-April 2005. *Table 2.1* shows the geographic distribution of surveys collected by the teams in the population centers and on transhumance routes and more rural areas. After the fieldwork was finished, all the completed questionnaires were compiled, translated into English, coded, and entered into Microsoft Excel by the researcher.

Table 2.1: Distribution of Surveys around Tchabal Mbabo

<i>Areas surveyed</i>	<i>Households</i>	<i>Population</i>	<i>Average per Household</i>
Mbabo	71	939	13.23
Tchabal Kesse	6	207	34.50
Mbontodje I	13	360	27.69
Mbontodje II	14	367	26.21
Bourle/Yangare	9	198	22.00
Hore Garbaya	3	74	24.67
Mayo Kelele	32	120	3.75
Dadawal/Fungoi	22	693	31.50
Hore Mayo Selbe	14	398	28.43
Mayo Lelewal	12	212	17.67
Tonde Wandou	9	159	17.67
TOTAL	205	3706	22.48

2.2.2 Survey Limitations

There was no sampling frame available for households living on the plateau. The number of households on the plateau is also not known but had been estimated as around 400 households with 7000 people (CNC 1987). The sample of households interviewed does reflect other estimates of the general geographic and ethnic distribution of families on the plateau (Boutrais 1995; CNC 1987; Tiayon 2004; Bombome *et al.* 2004). According to the census estimate of population, the sample captured 53% of the total regional population, including households from all settlement types and areas on the plateau.

All interviews were conducted with the (male) patriarchs of the families. The sole female team member fell ill on the first day and was unable to participate in any interviews. In local tradition visiting men are not allowed to converse freely with women. This limited interactions between females and the survey teams. The nature of this patriarchal society, with men having nearly complete power in the family, suggests that responses from women may have not deviated much from the responses of the patriarchs, particularly on the subjects of agriculture and herding. Women do not actively participate in agriculture or herding, but they are involved with domestic duties, forest uses, and sometimes with commercial interactions (i.e. selling dairy products).

Some survey respondents did not directly answer all survey questions. On the other hand, many respondents did provide detailed information that was quite discursive and not directly germane to the survey questions. The creation of the protected area is a politically charged event. Many agropastoralists desired to speak and be heard rather than answer formulaic questions. This information was noted by survey teams on the materials that were eventually compiled. Since survey responses were written by the transcriber on lined paper (not the survey form), the discursive data is often interwoven into the survey responses or noted at the end of

the responses. In some cases, these discursive monologues provide the missing answers to questions that were not directly addressed by the respondent. Therefore, for only the questions missing responses, content analysis of that interview's discursive data was conducted and used, when appropriate, to fill in missing data.

Despite using the above method, there were still some non-responses to particular questions in the survey data. Non-responses were labeled as "No Value" and omitted from the statistical analysis. For example, some pastoralists refused to answer questions about their herd size or numbers due to their lack of trust in outsiders. They were afraid it would affect their taxes. These non-responses were considered as "No Value" (rather than "zero head of cattle") in the descriptive statistics and non-parametric statistical tests.

2.2.3 Content-analytic Approach and Screen Development

Much of the data collected in the surveys was not necessary to answer the central question of this study. Therefore, content analysis was used to selectively screen the surveys for questions that were applicable to the practical and theoretical aspects of this study's key research question. *Content analysis* is a content-analytic approach that has historically been the dominant method of textual analysis (Busch *et al.* 2005; Carley 1993). This method allows the researcher to organize large amounts of textual data, "in terms of what words or concepts are actually used or implied" (Carley 1993). Content analysis can be automated or done by hand. I choose to do content analysis by hand with note cards and using the *find* function in Microsoft Word. Content analysis was used for three purposes in this study: first, to select survey questions pertinent to this study; then to extract meaning from respondent discourses during surveys in order to fill in non-responses to survey questions; and third to interpret the participant observation data by finding relevant data clusters in an indexing system used to organize the observations. In this section,

the first two applications of content analysis on survey data are covered. The third application of content analysis is covered in more depth in section 2.3 *Participant Observation*.

The first steps to conducting the above content analysis include developing a screen to identify those NRM behaviors that GGTM was interested in altering or supporting as well as those noted by other researchers as significantly different among the subethnic populations (Krathwohl 1998). GGTM was interested in NRM behaviors that threaten biodiversity, affect agropastoral productivity, or relate to resource access. Since GGTM's interest in NRM behaviors covered a wide spectrum of variables, only one screen was necessary. The behaviors researchers identified as different between subgroups were found to be within the set of variables that interested GGTM and no additional screen was required to extract these variables from the survey. For example, *Table 2.2* shows behaviors noticed by Boutrais (1991, 1995, 1999), Tiayon (2004) and Blench (1985) as different between subethnic groups. The behaviors listed in *Table 2.2* are just a few of the over 50 behaviors that were analyzed. The screen effectively selected

Table 2.2: NRM Behaviors Noticed by Researchers to Vary Between Subethnic Groups

<i>NRM BEHAVIORS NOTICED BY RESEARCHERS TO VARY BETWEEN SUBETHNIC GROUPS</i>
<i>Elevation of settlement</i>
<i>Location of settlement</i>
<i>Use of insecticides on cattle</i>
<i>Cattle breed owned</i>
<i>Selling of dairy products</i>
<i>Selling of agricultural products</i>
<i>Location of agricultural fields</i>
<i>Hectares in agriculture</i>
<i>Method of agricultural field preparation</i>

specific survey questions and observations that fell into four main categories: settlement characteristics, agricultural practices, forest uses, and animal husbandry.

The screen was applied through content analysis. The first instance that content analysis was used was during the identification of survey questions that relate to this study's focus on NRM behaviors. Answers could then be extracted and reorganized into tables so that the information could be analyzed with statistical software. The second application of content analysis was to attempt to fill in "No Value" answers on the survey by analyzing the discursive speech made by agropastoralists. Sometimes answers to the questions were left empty, but the agropastoralist provided the answer in a discursive monologue he gave during the survey. In effect, these discursive monologues were more like interviews that provided certain answers that content analysis could find and extract. In this process only explicit connections were used. There was no use of vague insinuations or extrapolation from the actual data. For example, if an agropastoralist would not respond when asked if he sent his cattle on transhumance, but then went on to talk about his experiences with transhumance or to complain that all his cows must leave during the dry season to find better pastures, then it seemed reasonable to change the survey's "No Data" response to a positive response: *yes, he does send his cattle on transhumance.*

2.2.4 Variables Extracted from Surveys for Statistical Analysis

Variables isolated from the surveys to be statistically tested were grouped into four categories: settlement characteristics, agricultural practices, forest uses, and animal husbandry. Below each of the 56 variables is listed with relevant notes and the statistical test to which it was subjected (Pearson's Chi-square test or the Kruskal-Wallis rank sum test). As will be explained in greater detail below, Kruskal-Wallis rank sum tests are robust to variances in normality, but assume equal variances. Therefore, all Kruskal-Wallis tests were preceded by Fligner-Killeen tests (a

robust test with null hypothesis that all groups have equal variances). This data is not considered to be comprehensive of all NRM behavior around the plateau, however it is representative of certain themes of NRM. Grouping the data into four thematic categories helps us look at the differences in these larger themes of NRM behaviors. Variables denoted by the asterisk are behaviors that researchers noted anecdotally to be different between subethnic groups.

SETTLEMENT CHARACTERISTICS (*= noted by researchers to differ by subethnic groups):

1. **Elevation of Settlement*:** A measure of the elevation (meters) of the household being surveyed. This was taken with the *Garmin eTrex Legend* GPS units that do not have a built in altimeter but rather use measurements of satellite orbits in reference to the WGS 1984 datum. The estimate of error for this system is +/- 100 meters 95% of the time. This measurement was taken for a comparison of the different elevations of subethnic settlements. Boutrais (1995) noticed that the Djafoun Mbororo settled the highest points of the plateau. Aku Mbororo settled lower echelons. Huya Fulbe were distributed throughout the elevations. Kruskal Wallis rank sum test (KW).
2. **Distance to Forests:** This measurement was observed by the survey team in meters. *Forests* were defined as by Chapman (2004) on the escarpment. The forested areas stand in marked contrast to the overgrazed *Sporobolus africanus* and *Hyparrhenia* grass pastures, see *Figure 1.6* (Chapman 2004; Shu 2004). This variable reflects a household's ability to extract fuelwood and other *non-timber forest products* (NTFP). This may be important when considering adoption of new forestry and agricultural technologies and for policy design. KW.
3. **Location of Settlement*:** This measurement was observed by the survey team as hilltop, hillside or valley area. Both Tiayon (2004) and Boutrais (1995) noticed that

Mbororo settlements were typically on top of hills, Huya Fulße were distributed throughout valley areas and scattered on hillsides and hilltops, and Aku stayed on hillsides and in valleys. Such a distribution may affect impacts on watersheds, possible involvement in forest clearing, and the balance of agricultural and pastoral prerogatives within the households. Pearson chi-square test (X^2).

AGRICULTURAL PRACTICES

4. **Practices Agriculture:** Agricultural practice was considered to involve land preparation, planting, and harvesting of annual or biennial crops. This variable suggests which groups have adopted more sedentary practices. X^2 .
5. **Sells Agricultural Products*:** Commercial sale of agricultural commodities is an important consideration in developing projects that support livelihoods. Boutrais (1995) and Tiayon (2004) suggest that the agropastoralists grow primarily for home consumption. X^2 .
6. **Uses Pesticides:** This suggests adoption of new technologies and has important ramifications on watershed health. X^2 .
7. **Uses Chemical Fertilizer:** All agropastoralists use manure as their main source of fertilizer. Use of chemical fertilizer suggests adoption of new technologies that have important ramifications on watershed health. X^2 .
8. **Seed Sources:** The respondents were asked whether they got most of their seeds from family members, seed-saving, government/NGO, market purchase, or other. This suggests whether or not seeds are shared on the plateau and the most important networks for new crops introduction. X^2 .

9. **Hectares in Agriculture*:** Size of fields was observed by survey teams. This is a cumulative measure of all the agricultural fields owned by the respondent and is the best indicator of the biggest agricultural producers in the area. KW.
10. **Location of Agricultural Fields*:** The location of agricultural fields on hilltops, hillsides, or valleys indicates the type of interactions with watersheds and possible forest clearing activities. Boutrais (1995) noticed a difference in field location with the Djafoun Mbororo largely on hilltops and the Aku Mbororo and Huya Fulße being more common in valley areas. Those who did not practice agriculture were considered as “no value”. X².
11. **Number of Uses of Agricultural Extension in the Last Year:** Indicates willingness to use government or NGO extension agents and suggests a possible way to interact and affect behavior change. KW.
12. **Method of Field Preparation*:** Respondents were asked to choose which method represented the most common way that they prepared fields: animal traction, mechanical, family labor, hired labor, or other. Boutrais (1995) noticed that most Djafoun Mbororo and many Huya Fulße hired out labor from lowland agriculturalists. Locals say that the use of cattle drawn plows is nonexistent. This suggests avenues to be pursued in changing agricultural behaviors while respecting regional and domestic economic networks. X².
13. **Plants Fruit Trees:** This behavior suggests stable land tenure and a significant change in pastoral behavior. It indicates early adopters of new agricultural technologies. X².

FOREST USES

14. **Purchase of Fuelwood:** All families collect fuelwood in the immediate vicinity. The purchase of fuelwood is a variable related to scarcity of forest resources. Purchasing fuelwood may indicate willingness to adopt forestry practices and suggest integration into a highly specialized economic system. X².
15. **Plants Trees for Fuelwood or Construction:** This indicates early adopters that have decided to settle permanently in one site and grow their own fuelwood or construction materials. It suggests which groups have more stable land tenure in the region. It could indicate Boserupian responses to overpopulation and lack of resources. X².
16. **Consumes Bushmeat:** Many Muslim families are thought to refuse consumption of bushmeat. Bushmeat is defined as any non-fish animal caught in the bush. It is not clear whether consumption of bushmeat is popular among the agropastoral subethnic groups that are at different stages of Islamization. Over the last year. X².
17. **Hunts Bushmeat:** This is important in exploration of local hunting practices, contrary to Vabi (1997) finding that most hunting occurs from outsiders. However, this does not suggest commercial activity. Over the last year. X².
18. **Sells Bushmeat:** This suggest commercial hunting. Over the last year. X².
19. **Buys Bushmeat:** This suggests familiarity with the bushmeat economy and possible behavior patterns that need to be focused on by GGTM. Over the last year. X².
20. **Harvests *Prunus africana*:** Suggest local use of this rare tree species. X².
21. **Sells *Prunus africana*:** Suggests commercial exploitation of this rare species, contrary to commonly accepted statements that agropastoralists do not directly participate in trade of this species. X².

22. **Sells *Non-Timber Forest Products (NTFP)* other than *Prunus africana*:** This behavior suggests further commercial extraction of plants from forests. X².
23. **Practices Apiculture:** Suggests a significant deviation from normal pastoral activities and possible use as a component in GGTM's extension for developing alternative livelihoods and boost the local economy. X².
24. **Practices Fishing:** Suggests a significant deviation from normal pastoral activities and possible use as a component in GGTM's extension for developing alternative livelihoods and boost the local economy. X².
25. **Cleared Forests in the Last Year:** This measure indicates activity in forest clearing. X².

ANIMAL HUSBANDRY

26. **Breed of Cattle Owned*:** Agropastoralists were asked to state whether their herds consisted of "pure" Djafoun, Daneeji (Aku), Gudali, Sokoto, Ma'Ineeji, Wakwa, European breeds, other, or some mix of the above breeds. Blench (1985) and Boutrais (1995) are two authors that have noticed the association of subethnic identity with cattle type and the ecological and economic adaptations that cattle breed imply. The type of cattle owned influences grazing practices and tells us about the economic goals of a group. Significant differences or lack thereof will be important in understanding much of the behavioral patterns among agropastoralists. X².
27. **Diversity of Herd:** Using the same data as above, the diversity of cattle breeds held was analyzed. No cattle raiser was found to have more than 4 breeds. Therefore cattle raisers were grouped into 1, 2, 3, or 4 breeds held. This is an important ancillary aspect of the data on breeds. It indicates a high amount of adaptation in the herd and calls into question whether herd management practices and goals are changing. X².

28. **Number of Cattle Owned:** This indicates larger herding interests on the plateau. KW.
29. **Sends Cattle on Transhumance:** Indicates active participation in transhumance. X².
30. **Amount of Time Cattle are on Transhumance:** The length of transhumance and how sedentary the subethnic groups are in comparison. Number of weeks. KW.
31. **Distance of Transhumance:** Indicates which populations are forced to search farther for grass during the dry season and how different groups may benefit more or less from GGTM led pasture development initiatives. KW.
32. **Routes Used on Transhumance:** There were five main routes that agropastoralists use: Ndogawa, Fungoi, Ngel Aku, Yukol, and Hore Deo. The respondents named the transhumance route of most importance for their herds. This indicates which routes are priority corridors for certain subethnic groups. This influences how the transhumance routes should be managed by GGTM. This also indicates whether there are significant subethnic or land tenure issues between the subethnic groups and how those play out in resource access. Such data could easily be integrated with ecological degradation indices of the routes and provide target populations for extension efforts. X².
33. **Herders Settle in One Region or Continually Migrate:** This indicates whether stable bonds between farmers and herders exist, whether there is enough grass production in the dry season lowland pastures, and whether GGTM development plans should factor in movement as part of their pasture development strategy. X².
34. **Geographic Regions Where Herders Go:** Specific as well as directional regions were in among the responses, but could be grouped as follows: Dodeo, Kinel, Badjara, Mayo Lelewal, Southern, Other. The geographic dispersion of subethnic groups indicates unique challenges that each group must overcome and how the project can manage resource access more equitably. X².

35. **Owns Waldé:** *Waldé* are herder camps. There is a system of land tenure on the northern face of the escarpment wherein the older and more honorable families in the community are vested with management powers over the routes and adjoining pastures. The waldé serve as pauses for some migrating herders, but are the permanent dry season location for some other herders. Ownership of waldé may have important implications for managing resource access, gauging impacts on community leadership, and looking at transhumance behaviors. Who has a vested interest in the continued productivity of the pastures on the northern escarpment? The geographic section of this study looks more in depth at the distribution of waldé in the core project areas and by vegetation type. X².
36. **Who Goes with Cattle:** Cattle raisers (agropastoralists) were asked to state whether their herders were entire subdivisions of the family, hired herders, just sons, or other. This indicates how labor is divided in the family and can also indicate the how sedentary an agropastoral family has become. X².
37. **Number of Conflicts over Pastures with Cattle Raisers:** Over the last year. This indicates presence in areas that have high amounts of pasture competition between cattle raisers. This has important implications for GGTM's regional emphasis on pasture development. KW.
38. **Number of Conflicts over Pastures with Farmers:** Over the last year. This indicates presence in areas that have high amounts of pasture competition between cattle raisers and farmers. This has important implications for GGTM's regional emphasis on pasture development. KW.
39. **Number of Conflicts with Wild Animals:** Over the last year. This indicates possible involvement in grazing in areas where wild animal migration corridors are more common. GGTM can use this information to focus in on groups that are likely to have

- specialized knowledge of animal migration paths, have more conflicts with wild animals, and be more likely to protest the project's encouragement of wild animal population recovery. KW.
40. **Owns Sheep:** Indicates diversification. X².
 41. **Owns Donkeys:** Indicates diversification and also relative remoteness of a family.X².
 42. **Owns Goats:** Indicates diversification.X².
 43. **Owns Fowl:** Indicates diversification.X².
 44. **Owns Dogs:** Indicates diversification and possibly hunting activities.X².
 45. **Owns Horses:** Indicates diversification and the relative remoteness of family.X².
 46. **Family Sells Dairy Products in Market*:** Indicates reliance of dairy productivity as a source of income in the family and can also indicate Islamization of the family, sedentarization, and diversification of income. This is important in GGTM's implementation of development programs because it indicates what cattle breeds are more preferable. Boutrais (1995) points to this behavior difference in his analysis of economic activities and explanation of how cattle breed reflects cultural, ecological, and economic adaptation by agropastoralists around Tchabal Mbabo. X².
 47. **Use of Insecticides on Cattle*:** This indicates adoption of modern cattle raising technology. The adoption of this technology can also hint at use of veterinary services, possible roles in spreading tsetse vectors, and which populations are already involved in local networks involving insecticides and medicines. This was noticed to differ between the Aku, Djafoun, and Huya by Boutrais (1999). X².
 48. **Use of Veterinary Extension Services:** Indicates willingness to use government and NGO extension services. X².
 49. **Vaccinates Cows:** Indicates adoption of modern veterinary practices. X².

50. **Plants Pasture:** Indicates early adopters of new pasture technologies. X².
51. **If Resources are Available, Would Prefer to Stop Transhumance (keep all cows on plateau year-round):** Indicates willingness to stop transhumance. X².
52. **GIC Membership:** Under the initiative of MINEPIA and other NGOs, there has been an effort to organize herders into officially recognized community groups that can interact with government agents and benefit from aid. This union of groups is called *Union des Groupements d'Initiatives Commune (GIC) du Comité d'Eradication de Tsé-Tsé en Adamaoua* or UGICETA. The GIC is the local community group. Involvement in these groups indicates participation in development and ways that GGTM can approach development in the region. The GIC leaders have tried to manage NRM behaviors such as insecticide application, transhumance route use, use and timing of bushfires, and many other activities. X².
53. **Number of Cattle Sold in Last Year:** Indicates reliance on beef rather than dairy market, possible cattle richness, or the amount of stress on a particular group which is causing them to liquidate resources. KW.
54. **Location of Cattle Sold:** Indicates how cattle market development might impact different subethnic groups. X².
55. **Does Cattle Raiser Burn Around Homestead:** The cattle raiser is different from the herder. A herder does not imply ownership, although some herders do own their cows. The cattle raisers' decision to burn highland pasture is not related to herders' decisions to burn lowland pastures or bush. This reflects use of burning on the plateau as a pasture management strategy. X².

2.2.4 Coding

I am using the term *coding* explicitly in reference to statistical analysis. *Coding* was used during the permutation of survey data into tabular forms that could be processed in either Pearson's chi-square contingency tables or in the Kruskal-Wallis rank sum test. After the data were coded it could be run through the 'R' statistical package.⁴² Chi-square coding involved converting data into a bivariate tabular analysis form wherein the actual observed frequencies of a phenomenon could be compared with the expected frequencies. Expected frequencies are based on the assumption that data would be equally distributed among different behaviors if there were no relationship between subethnic groups (independent variable) and NRM behaviors (dependent variables). Pearson's chi-square test is a nonparametric test that makes no assumptions about the distribution of the data or the type of the data (ordinal, nominal, ratio, or interval). Coding and ranking for the Kruskal-Wallis test was automatically performed by the statistical program on ratio and interval data. The statistical software transformed the data from interval and ratio to ordinal in order to create rank orders available for analysis in the Kruskal-Wallis rank sum test.

2.2.5 Pearson's Chi-square Test

Pearson's chi-square test assumes that: sample data are random, there is a sufficiently large sample size ($N > 20$), adequate cell size (5 or more per cell in 80% of the cells in greater than a 2*2 table), independent observations, similar distribution of groups, non-directional hypothesis, and homoskedacity. In this study all nominal data were processed using Pearson's chi-square test. The formula for chi-squared calculations is, where x_i is the actual observed frequency and E_i is the expected frequency:

⁴² 'R' is an open source statistical package licensed under GNU GPL.

$$\begin{aligned} \chi^2 &= \frac{(x_1 - E_1)^2}{E_1} + \frac{(x_2 - E_2)^2}{E_2} + \dots + \frac{(x_k - E_k)^2}{E_k} \\ &= \sum_{i=1}^k \frac{(x_i - E_i)^2}{E_i} \end{aligned}$$

Figure 2.1 Chi-square formula

Degrees of freedom (df) for a table can be summarized as $[df = (r - 1) * (c - 1)]$ where r is the number of rows and c is the number of columns (Agresti & Finlay 1986). In this research $\alpha = .05$ (a chi-square probability of .05 or less is considered justification to reject the null hypothesis). The chi-square test uses a chi-square distribution table when the sample size is large enough (as it is in with data in this study).

The null hypothesis states that there is no true relationship between the independent and dependent variable; the null hypothesis expects an even distribution of frequencies across the categories. The alternative hypothesis states that there is a true relationship between the independent and dependent variable and expects frequencies to be unequal across categories. The chi-square tests the null hypothesis by calculating if the difference between the observed and expected frequencies in each category could have resulted from chance sampling error or because the dependent variable has an association with the independent variable.

2.2.6 Kruskal-Wallis Rank Sum Test

Typically analysis of variance for $k > 2$ can be done with the robust ANOVA test. However, the ANOVA loses its ability to be robust to some of its central assumptions, homoskedacity and normality, when group sample sizes are not even or large. In this study, we have taken a representative slice of the population, but the Aku Mbororo, Djafoun Mbororo, and Huya Fulße group sample sizes are quite disparate (*Table 2.3*). Quantile-quantile plots and the Shapiro-Wilks

Table 2.3 Size of Subethnic Sample Populations. Lineages with “0” were found by Boutrais (1995), but not by the present study.

Lineage	Subethnicity	#	Percentage
Gosi	Djafoun Mbororo	33	
Aoutanko	Djafoun Mbororo	13	
Faranko	Djafoun Mbororo	42	
Dabanko	Djafoun Mbororo	2	
Ringuimadji	Djafoun Mbororo	9	
Toukanko	Djafoun Mbororo	5	
Djaranko	Djafoun Mbororo	0	
Madjanko	Djafoun Mbororo	10	
Rijimanko	Djafoun Mbororo	8	
Bawanko	Djafoun Mbororo	2	
Djalanko	Djafoun Mbororo	0	
		124	60.49%
Boutanko	Akou Mbororo	31	
Gamanko	Akou Mbororo	15	
Mbewebbe	Akou Mbororo	10	
Pikadji	Akou Mbororo	1	
Djoranko	Akou Mbororo	0	
Natirbe	Akou Mbororo	0	
		57	27.80%
Mbewe	Fulbe	10	
Kilba	Fulbe	0	
Wuiti	Fulbe	11	
Soukour	Fulbe	1	
Isho	Fulbe	2	
		24	11.71%
TOTALS		205	100.00%

test were used to inspect normality. The *subethnic* divisions of data consistently lacked normality. ANOVA is not robust when faced with deviations from normality and disparate sample sizes.

The Kruskal-Wallis rank sum test is the nonparametric analog to ANOVA that can be used in this case where assumptions of the ANOVA are violated. It is a ranking nonparametric test that analyzes variance of medians for $k > 2$. The Kruskal-Wallis assumes: sample data are random, independent observations, similar distributions, homoskedacity, and ordinal values (Garson 1976; Hollander & Wolfe 1999). This method does not assume a Gaussian distribution, though data must still be continuous and the method maintains the requirement that the populations be identical under the null. Although generally literature maintains that all

distributions must be identical, some authors say that the Kruskal-Wallis test does examine variance as well as location of distributions. According to Wilcock (2001), “Any departure from equally shaped distributions may also cause the test to reject... The Kruskal-Wallis test is in fact much more likely to detect small location shifts than small shape differences, as desired, but can reject for either type of difference between distributions.” The Kruskal-Wallis test, unlike the parametric ANOVA does not assume normality and is robust to deviations in the data including imbalances of group sample sizes (VassarStats 2005).

To compute the Kruskal-Wallis test we can follow Hollander & Wolfe (1999):

Where r_{ij} is the rank of X_{ij} then,

$$R_j = \sum_{i=1}^{n_j} r_{ij} \quad \text{and} \quad R_{.j} = \frac{R_j}{n_j}, \quad j = 1, \dots, k.$$

Figure 2.2: Equation of ranking sum and ranking average.

R_j would be the sum of the joint ranks related to the independent variable, and $R_{.j}$ is the average of these same joint ranks. The Kruskal-Wallis statistic H is:

$$\begin{aligned} H &= \frac{12}{N(N+1)} \sum_{j=1}^k n_j \left(R_{.j} - \frac{N+1}{2} \right)^2 \\ &= \left(\frac{12}{N(N+1)} \sum_{j=1}^k \frac{R_j^2}{n_j} \right) - 3(N+1), \end{aligned}$$

Figure 2.3: Kruskal Wallis test formula for H .

Where the average rank assigned in the joint ranking is,

$$(N+1)/2 = \left(\sum_{j=1}^k \sum_{i=1}^{n_j} r_{ij} / N \right)$$

Figure 2.4: Average rank assigned to the joint ranking.

The null hypothesis that all populations have similar distributions is:

$$H_0 : [\tau_1 = \dots = \tau_k]$$

Figure 2.5: Kruskal-Wallis test H_0 .

The alternative hypothesis finds that there is a difference in the distributions,

$$H_1 : [\tau_1, \dots, \tau_k \text{ not all equal}],$$

Figure 2.6: Kruskal-Wallis test H_1 .

Using $\alpha = .05$: Reject H_0 if $H \geq b_\alpha$; otherwise do not reject.

In the event of ties in the ranking, it is recommended to use an *adjusted* $H = H'$, so that:

$$H' = \frac{H}{1 - \left(\sum_{j=1}^g (t_j^3 - t_j) / [N^3 - N] \right)},$$

Figure 2.7: Kruskal-Wallis test adjusted H .

Where t_j is the number of observations with rank j , and N is the size of the combined data set.

According to Hollander & Wolfe (1999), due to the Behrens-Fisher problem the Kruskal-Wallis test is not robust to heteroskedacity. As Wilcock (2001) noted above though the Kruskal-Wallis test does sometimes reject due to heteroskedacity. In any case, it is necessary to show that equal variances are present in the data samples by using a median variance test that is robust to deviations in normality. Although some authors recommend using the Rust-Fligner modification of the Kruskal-Wallis test (Hollander & Wolfe 1999), others see the Rust-Fligner modification as not very useful:

The Rust-Fligner test referred to isn't very useful because of the requirement of symmetry, and due to its questionable accuracy. (Sutton 2005)

More recently, Rust & Fligner (1984) develop a complicated adjustment to the Kruskal-Wallis test, which seems to do little more than make the use of the method more difficult, and results in assumptions which are identical to the original version. The claim is made that their test is more robust to departures of spread, but the

tables of simulation results show their test to be only a slight improvement over the original method. (Wilcoxon 2001)

A robust method of testing equal variance in groups despite lack of normality is the Fligner-Killeen method (Conover *et al.* 1981). Therefore, all Kruskal-Wallis tests were done after passing data through the Fligner-Killeen method, at $\alpha=.05$.

2.3 Participant Observation

2.3.1 Participant Observation Data Collection

Participant observation is a fieldwork method wherein a researcher takes an active role in a community in order to compile a rich, detailed, descriptive base of notes from which theory can be tested or evolve (*grounded theory*). I used participant observation throughout my stay in the Tchabal Mbabo region to gather a rich data set that could inform survey development and be used to field check survey information. Since participant observation involves copious amounts of notes, it is necessary to organize observations into an indexed system where they can be inspected.

My most intensive period of participant observation was during a month long period when data was collected on transhumance routes in the area; yet, participant observation occurred continuously over a 20-month period through informal interviews, work and personal relationships, and spontaneous involvement in community activities. Informal interviews included all ethnic groups in the area and represented men, women, and children. The descriptive observations gathered during participant observation included both quantitative and qualitative data. Observations were collected by following guidelines set out by Patton (1990) and Neuman (2000) for participant observation. Patton (*ibid.*) recognizes five dimensions of

participant observation: role of the observer, portrayal of role to others, portrayal of study purpose to others, duration of observations, and focus of observations.

Patton breaks the role of the observer into three categories that reflect increasing involvement in activities with communities: onlooker, partial observation, and full participant observation. My role as an observer can be considered a “partial observation”. I was employed by the Peace Corps as an agropastoral consultant for a local NGO and I lived in a local community named Galim. I earned the trust of the agropastoral community around Tchabal Mbabo by interacting with the Gosi Djafoun Mbororo clan as an extension agent. My role as an extension agent spread throughout the plateau and eventually I was engaged with most Huya Fulbé and Djafoun Mbororo lineages. As I worked with the agropastoralists their trust in me and my actions grew to a point that after a year, it became natural to have me there. I also learned to operate in the local language, *Fulfuldé*, which offered me an immeasurable amount of respect from the agropastoralists who knew that I spoke. It also allowed me to understand many of the nuances of their statements as well as things they would say to each other when they believed that I or other researchers did not understand. Although I made observations on activities- such as cattle herding on the plateau, transhumance, and other NRM extraction behaviors- I was not a full participant in any of these activities. My role as an extension agent and the time I spent recording transhumance paths exclude me from being just an onlooker and make my methods fit “partial observation”.

The portrayal of my role and study purpose to others was completely straightforward. The goals of my work and observations were well known among the agropastoralists. In the case of the transhumance routes, the agropastoral community supported my work thoroughly and asked me to represent them to officials of GGTM in discussion of their rights to access trails. For many there I was considered an extension agent and a teacher/researcher.

Patton (1990) breaks down duration of observations as: single observation, several observations, and long-term multiple observations. My observations were long-term since they took place over 20 months and occurred multiple times. He also recognizes three categories of observation focus: narrow focus, expanded focus, and broad focus. Narrow focus observes a single element; expanded focus observes a predetermined set of factors; and broad focus observes a holistic view of the situation. My observations were focused on a predetermined set of factors involving NRM. The duration and focus of my observations were long-term with multiple observations of expanded focus on behavior patterns. All observations were subjected to *content analysis* to find relevant data for the study's central question.

2.3.2 Indexing

I make a distinction between *coding* and *indexing* in this study in order to avoid confounding terms and actions. In general, the term “coding” is used to represent two distinct acts: the permutation of data into forms that can be analyzed by statistical tests (which I call *coding* in this study) and the sorting of participant observation data into an index system (which I call *indexing*). So as used in this study, *coding* will only refer to statistical test as mentioned in the section above. The term *indexing* is used to represent the process of organizing participant observations into a manageable system wherein data clusters can be simultaneously extracted according to the desired level of analysis.

When using automated programs to index and code data certain implicit assumptions are taken by software about the relationship of terms. This can significantly affect control over the steps of content analysis (Busch *et al.* 2005; Palmquist *et al.* 1997). For this reason I chose to develop an indexing system and do content analysis by the traditional method of using note

cards and using simple functions in Microsoft Excel. Organization of the data into matrices was also used to help examine and visualize classification of data types (Miles and Huberman 1998).

Indexing was carried out following guidelines set forth by Krathwohl (1998) who actually refers to “coding as indexing”, Strauss (1987), Miles & Huberman (1994), and Gans (1962). Data was assigned a unique code based on the date the observation occurred and the chronological order of observations that day. For example, the 58th observation taken on 10 March 2004 would have the unique code “100304.0058” where one finds “daymonthyear.observation#”. Like Gans (ibid) the data was organized on note cards to facilitate organization and visualization of relationships between observations. The indexing hierarchy was then created by the researcher who assigned the four general NRM categories letters A, B, C, and D. Within each of these categories data characteristics were represented by an alphanumeric system. All data was associated within the hierarchy according to the data’s characteristics. The data was entered into Microsoft Excel in the format shown in *Table 2.4* (this is a hypothetical arrangement and not representative of my true data) where rows show the unique identity number for each data parcel and the columns represent a characteristic with which they can be associated.

Table 2.4: A hypothetical example of the indexing system used for participant observation data.

UNIQUE ID	A1a	A1b	A1c	A1d	A1e	A1f	A1g	A1h	A2a	A2b	A2c	etc.
100304.0001	0	0	1	0	0	1	0	0	1	0	1	x
100304.0002	0	1	0	0	0	0	1	1	1	1	0	x
100304.0003	0	1	0	0	0	1	0	0	0	0	0	x
100304.0004	1	0	0	0	0	0	0	1	0	1	0	x
100304.0005	1	0	0	0	0	1	0	0	1	1	1	x

One immediately sees that this data set represents the first five observations collected on 10 March 2004. The columns shown describe certain activities. All the *A1* columns describe an agricultural activity. All the *A2* columns describe characteristics of principal actors. For example

the first entry represents information on harvesting (A1b) and employment activities (A1f) wherein the principal actors were identified (A2a), their ethnicity was identified (A2c), but they were not present (A2b). Such a statement might be from an extension worker who says “Djafoun Mbororo hire Koutine agriculturalists from the Mayo Baleo area to harvest the Mbororo corn at 10,000FCFA a week.” Obviously there are other bits of information in this sentence (specifically the *wage rate*, the *crop harvested*, and the exact subethnic group) that would be represented in other columns. The data was not always described in a binary format, as shown in this example. This indexing system allowed the researcher to group observations in ways that made relationships between observations and ancillary information clusters more immediately evident. After the participant observations were indexed in a system that recognized the relationships between them, content analysis could be performed.

2.3.3 Content-analytic Approach and Screen Development

As mentioned above, content analysis was used three times during this study. The first two instances were involved in extracting relevant information from the surveys. The third application of content analysis occurred on the participant observation data. Participant observation is widely known as a method that creates abundant amounts of descriptive data. All of this data, like the surveys, was not relevant to this study. The participant observation data was screened in the same way as the surveys in order to extract information germane to the study.

Before the participant observation data was screened, it was organized into an index system that connected relevant observations to ancillary data that qualified those observations. For example, when an agropastoralist said that he cannot sell his cattle in Mbabo (the local market) so he is going to travel to Ganye (a more distant market) there is body of relevant data

connected to such an act: his cattle breed, the number of cattle he is traveling with, which route he will take, his ethnicity, any price information from Mbabo or other markets, the condition of his cattle, and so on. When the screen identified pertinent observations, the observations and the ancillary, indexed data could be extracted together. This data was not analyzed statistically, but was used to create the survey, to inform interpretation of the survey results, and to indicate where survey results may be inaccurate or incomplete. It is extensively used in the ethnographic presentation of this study's results.

2.4 Geographic Distribution

2.4.1 Importance of Geography to Theoretical and Practical Applications

One of the objectives of this study is to present the geographic distribution of the findings of the survey data. This perspective can help further explore dimensions of this study's question about subethnic identity and NRM behaviors. This data can also inform policy. However, my main impetus in including this information in the study is to document a unique moment in the history of Tchabal Mbabo and for exploratory research. That is to say that, the association between the geographic distributions of ecological degradation, subethnic groups, and NRM behaviors may call in to question many things.

For example, settlements of subethnic groups are geographically clustered; NRM behaviors may also be clustered. If there are indications of NRM behavior clustering irrespective of subethnic group, this suggests other alternatives to how policy can be developed. If the distribution of ecological degradation is not similar to the distribution of certain NRM behaviors considered harmful to the environment, further research into the actual causes of degradation should be explored. There are many other important theoretical questions latent in the data. Is there a geographic concentration of early adopters of technology? And if there is, does adoption

of new technologies or behavioral patterns suggest Boserupian intensification (is their area more environmentally degraded and more populated than regions where adoption is not occurring)? Or is non-Boserupian theory, like the shifting of ethnic affiliations and alliances in over populated and degraded areas more evident (Stone and Downum 1999)?

Moreover, the documenting of geographic distribution of NRM and subethnic populations before the implementation of GGTM can facilitate longitudinal studies that look at the effects of GGTM on demography and NRM behaviors. In other words, geographic distributions can be important indicator of project impact and policy efficacy.

2.4.2 Field Data GPS Collection

During the collection of surveys *Garmin eTrex Legend* recreational GPS units were used to georeference the location of surveyed homes across the plateau. This documentation will be important in follow-up studies and, as mentioned above, in exploratory data analysis. Since recreational units were used, waypoint averaging, dilution of precision, and other features that control precision and accuracy were not available. There were no available base stations within 500km that could be used to correct the GPS data. However one main benefit of the local ecology was that most of the GPS points were taken in the open savanna with few trees or other interferences to signals. As well, readings were taken during the dry season, so atmospheric storms were not present. Accuracy can generally be stated as between 10m-20m, no better. All data was downloaded from the Garmin units using the program DNR Garmin. The data is in the WGS 1984 datum and projected in UTM Zone 33N.

The collection of GPS points on transhumance routes was slightly different from the survey data in that the lowland areas and cliffs occasionally had dense forest which caused the

receiver to lose reception. The following parameters were adopted to help maintain route integrity and to give ample observations on route characteristics.

Tracks were recorded as follows:

- Recording took place at 200 meter intervals
- Recording was performed for the duration of the trip

Pertinent Waypoints were taken as follows:

- At no more than 1km apart
- When significant (more than 20° compass) change in route trajectory
- Human settlement or construction
- Natural resource extraction (wood cutting, cattle grazing, hunter traps, etc.)
- Vegetation change
- Vegetation of interest (*Prunus africana* and other notable species)
- Presence/ Sightings of animals
- Important natural phenomena (mineral springs, river crossings, etc.)

2.4.3 Remote Sensing Data

Remote sensing data was provided from a variety of sources. Data on vegetation cover was derived from *Landsat 7 Enhanced Thematic Mapper (ETM+)* (p185 r054-055 & p186 r054-055 from 19 Jan 2003 and 10 Jan 2003 respectively) images by Shu (2004). Shapefiles of the vegetation coverage and road structures were provided by Shu in July 2005.

Shuttle Radar Topographic Mission (SRTM) data was provided by the National Geospatial Intelligence Raster Room interface in tiff format. Performing GIS functions on SRTM data at 90m resolution provided additional ecological information. SRTM data was provided by the National Geospatial Intelligence Raster Room interface in tiff format.

Extraction of watersheds was done with ESRI ArcHydro. Contour lines were extracted at 100m using Spatial Analyst (ArcGIS ArcView).

Orthorectified Landsat images were provided by Landsat.org in affiliation with the Tropical Rainforest Information Center. These images (specifically image #p85r055_7p20001212_z33_nn80) were subsetted into smaller files using Hawth's Analysis Tools extension for ArcGIS. The images were then rendered into three-dimensional formats using ArcScene and served as the base layer for presentations of other data.

2.4.4 Analyzing Geographic Data

All map layouts were created in ESRI ArcGIS 8.3. All data was projected in UTM 33N WGS 84 with geographic coordinate system WGS 1984. GPS points were converted into shapefiles and layered with remote sensing data. Analysis of the data was done with the following functions: select by attributes, select by location, cell statistics, zonal statistics, raster calculator, and functions from Hawth's Analysis Tools. For further information on actual procedures see the GIS procedure log in *Appendix ###*. Unless otherwise noted, the bounding coordinates of analysis and subsets are defined by:

7°40'60 N	7°1'30N
11°49'59E	12°31'20E

CHAPTER 3: RESULTS AND ANALYSIS

3.1 Statistical Comparison of Variance in Dependent Variables

3.1.1 Organization of Data

Data isolated from the surveys to be statistically tested were grouped into four categories: settlement characteristics, agricultural practices, forest uses, and animal husbandry. Nominal data was tested with Pearson's Chi-square Goodness of Fit test. For interval data, I used the Fligner-Killeen test and Kruskal-Wallis rank sum test. In order to conduct the Fligner-Killeen test and Kruskal-Wallis rank sum test, data were permutated from interval data into ordinal data. The Fligner-Killeen test for homogeneity of variances (*HOV*) was done before each Kruskal-Wallis test. The Fligner-Killeen (FK) test examined the null that the variances in each of the groups were the same. If the Fligner-Killeen test found that the data did not have homogeneity of variance (rejection of null hypothesis at $\alpha = .05$, $df = 2$), the Kruskal-Wallis (KW) results could not be strongly supported. The presence of ties in the KW test called for the use of the adjusted- H (H') explained above.

Below, in *Table 3.1*, each of the 55 variables is listed with the results of the statistical analysis conducted on it. The data were grouped in this order to provide a more informative examination of the different categories of NRM behaviors. This organization will allow GGTM to develop thematic extension categories focused on subethnic groups when such division is applicable. Unless otherwise noted the analyses were conducted on data with $N=205$: 124 Djafoun Mbororo, 57 Aku Mbororo, and 24 Huya Fulße households.

Table 3.1 Summary of Statistical Tests on 55 Behaviors Selected from the Survey Data

SETTLEMENT CHARACTERISTICS:	N	DF	Fligner-Killeen Test			Kruskal -Wallis Test			Pearson's X ² Goodness of Fit Test		
			Median X	p-value	Null	H	p-value	Null	X ²	p-value	Null
Elevation of Settlement*:	205	2	15.3891	0.0005	reject	26.6810	<.0001	reject	x	x	x
Distance to Forests:	205	2	4.9239	0.0853	cannot reject	17.5573	0.0002	reject	x	x	x
Location of Settlement*:	205	4	x	x	x	x	x	x	31.56	<.0001	reject
AGRICULTURAL PRACTICES	N	DF	Median X	p-value	Null	H	p-value	Null	X ²	p-value	Null
Practices Agriculture*:	205	2	x	x	x	x	x	x	80.27	<.0001	reject
Sells Agricultural Products:	205	2	x	x	x	x	x	x	58.55	<.0001	reject
Uses Pesticides:	205	2	x	x	x	x	x	x	39.83	<.0001	reject
Uses Chemical Fertilizer:	205	2	x	x	x	x	x	x	4.34	0.1142	cannot reject
Seed Sources:	149	8	x	x	x	x	x	x	42.73	<.0001	reject
Hectares in Agriculture*:	205	2	7.497	0.0235	reject	0.0500	0.9445	cannot reject	x	x	x
Location of Fields*:	149	4	x	x	x	x	x	x	25.57	<.0001	reject
Use (#) of Agricultural Extension:	205	2	4.4979	0.1055	cannot reject	13.5223	0.001158	reject	x	x	x
Method of Field Preparation*:	149	8	x	x	x	x	x	x	37.26	<.0001	reject
Plants Fruit Trees:	205	2	x	x	x	x	x	x	40.7	<.0001	reject
FOREST USES	N	DF	Median X	p-value	Null	H	p-value	Null	X ²	p-value	Null
Purchase of Fuelwood:	205	2	x	x	x	x	x	x	5.81	0.0547	cannot reject
Plants Wood for Fuel or Construction:	205	2	x	x	x	x	x	x	56.3	<.0001	reject
Consumes Bushmeat:	205	2	x	x	x	x	x	x	5.6	0.0608	cannot reject
Hunts Bushmeat:	202	2	x	x	x	x	x	x	6.86	0.0324	reject
Sells Bushmeat:	205	2	x	x	x	x	x	x	4.71	0.0949	cannot reject
Buys Bushmeat:	205	2	x	x	x	x	x	x	28.05	<.0001	reject
Harvests <i>Prunus africana</i> :	178	2	x	x	x	x	x	x	5.38	0.0679	cannot reject
Sells <i>Prunus africana</i> :	178	2	x	x	x	x	x	x	0	1	cannot reject
Sells NTFP, not <i>Prunus africana</i> :	200	2	x	x	x	x	x	x	4.59	0.1008	cannot reject
Practices Apiculture:	205	2	x	x	x	x	x	x	0	1	cannot reject
Practices Fishing:	205	2	x	x	x	x	x	x	0	1	cannot reject
Cleared Forests in the Last Year:	205	2	x	x	x	x	x	x	22.42	<.0001	reject
ANIMAL HUSBANDRY	N	DF	Median X	p-value	Null	H	p-value	Null	X ²	p-value	Null
Breed of Cattle Owned*:	205	16	x	x	x	x	x	x	159.8522	<.0001	reject
Diversity of Herd:	205	2	0.4046	0.8169	cannot reject	4.8829	0.08703	cannot reject	x	x	x
Number of Cattle Owned:	169	2	22.5979	<.0001	reject	23.5305	<.0001	reject	x	x	x
Sends Cattle on Transhumance:	205	2	x	x	x	x	x	x	4.2	0.1225	cannot reject
Transhumance Duration:	205	2	0.9249	0.6298	cannot reject	0.5791	0.7486	cannot reject	x	x	x
Distance of Transhumance:	175	2	86.9729	<.0001	reject	76.2487	<.0001	reject	x	x	x
Routes Used on Transhumance*:	205	8	x	x	x	x	x	x	21.1422	0.0068	reject
Herders Settle or Continually Migrate:	196	2	x	x	x	x	x	x	8.9309	0.0115	reject
Transhumance Destinations:	196	10	x	x	x	x	x	x	71.42	<.0001	reject
Owns Waldé:	205	2	x	x	x	x	x	x	3.76	0.1526	cannot reject
Herder Type, Transhumance:	205	6	x	x	x	x	x	x	110.3591	<.0001	reject
Number of Conflicts with Cattle Raisers:	205	2	11.2709	0.0036	reject	18.7923	<.0001	reject	x	x	x
Number of Conflicts with Farmers:	205	2	20.1417	<.0001	reject	34.6551	<.0001	reject	x	x	x
Number of Conflicts with Wild Animals:	205	2	2.2913	0.318	cannot reject	12.7185	0.0017	reject	x	x	x
Owns Sheep:	205	2	x	x	x	x	x	x	69.94	<.0001	reject
Owns Donkeys:	205	2	x	x	x	x	x	x	9.62	0.0081	reject
Owns Goats:	205	2	x	x	x	x	x	x	77.12	<.0001	reject
Owns Fowl:	205	2	x	x	x	x	x	x	2.6	0.2725	cannot reject
Owns Dogs:	205	2	x	x	x	x	x	x	30.77	<.0001	reject
Owns Horses:	205	2	x	x	x	x	x	x	61.28	<.0001	reject
Family Sells Dairy Products in Market*:	200	2	x	x	x	x	x	x	138.1	<.0001	reject
Use of Insecticides on Cattle*:	205	2	x	x	x	x	x	x	8.37	0.0152	reject
Number Times Vet Service Used:	203	2	13.4954	0.0012	reject	59.8877	<.001	reject	x	x	x
Vaccinates Cows:	204	2	x	x	x	x	x	x	5.46	0.0652	cannot reject
Plants Pasture:	205	2	x	x	x	x	x	x	9.39	0.0091	reject
Would Prefer to Stop Transhumance:	195	2	x	x	x	x	x	x	13.29	0.0013	reject
GIC Membership:	205	2	x	x	x	x	x	x	140.52	<.0001	reject
Number of Cattle Sold in Last Year:	181	2	0.0786	0.9615	cannot reject	3.8793	0.1438	cannot reject	x	x	x
Location of Cattle Sold:	183	18	x	x	x	x	x	x	77.73	<.0001	reject
Cattle Raiser Burns Around Homestead:	178	2	x	x	x	x	x	x	4.32	0.1153	cannot reject

3.1.2 Settlement Characteristics

The results of tests on all three variables in this section suggest highly significant differences between the subethnic groups. The Fligner-Killeen test showed that the data on elevation of settlements does not have homogeneity of variance between the subethnic groups. However, the strong *H statistic* suggests that we should accept these results. There were not ties in this data set, so an *H'* was not necessary. Results indicate that the Djafoun settle in the highest areas and the Aku in the lowest. The Huya settlements have the greatest amount of variance and the greatest range of the three subethnic groups. These results follow observations made by Boutrais (1995) and Green & Tchinelé (2004).

Table 3.2: Summary of Elevation Data.

	Djafoun	Aku	Huya
Mean	1885.70	1627.09	1746.24
CI (95%)	51.35	57.49	142.37
Standard Deviation	288.89	216.67	337.17
Minum	1400.58	1214.09	1212.15
Maximum	2389.39	2053.27	2251.34

The subethnic groups did show significant differences in the distance to forests. The Aku settled the closest to forested areas with a mean distance of 0.3 km. The next closest were the Huya, who had a mean average distance of 0.9 km. The Djafoun were the most distant at 1.3 km. Most Djafoun are settled in areas that may have never been forested or were deforested long ago and continue to lack trees due to heavy grazing, while the Huya and Aku seem to be the closest to woodland frontiers. This variable may be related to many other behaviors such as forest clearing, agricultural practice, conflicts with animals, etc.

The decision of where to locate a settlement reflects a NRM decision in that exposure of cattle to disease vectors, increased soil fertility, and access to forests are all facets of settlement location. The location of settlements showed a highly significant association with subethnic

groups. Of the Djafoun, 65% were found on hilltops. The majority of Huya were evenly distributed between hilltops and hillsides. The Aku (40%) settled in the valley areas more than hillsides or hilltops. The location of the Aku in valleys can be explained by their migration into the region after the valleys had been sprayed to kill tsetse flies. The valleys were attractive areas until the tsetse reinvaded. As well, being in the lowland areas did predispose them to more contact with agricultural communities; however, this region is still relatively sparsely populated in terms of humans (12 per km²) but not for cattle. The valleys are often still wooded or not settled by agriculturalists. While this result was expected due to previous literature that suggested there should be a difference between the locations of settlements, the most surprising result was that 60% of the Aku were settled outside of valleys. It seems that it would have been difficult for them to move up the plateau ramparts into good pasture in such high numbers. This could possibly indicate a high rate of Aku movement up the hillside into marginal grazing areas (steep slopes and high proportions of browse) that the Djafoun and Huya are not using.

In summary, there is significant evidence to conclude that the subethnic groups settle in different ecological locations, elevations, and distances to forests. These results follow previous literature, but say nothing about longitudinal trends or if there is an attenuation of such associations.

3.1.3 Agricultural Practices

Most of the households, 72%, practice agriculture. However there was a highly significant difference between the subethnic groups. Most Djafoun and Huya practiced some form of agriculture. Amongst the Aku, only 22% practiced agriculture, the rest were involved with herding their own herds, hired herding, and the sell of dairy products. Perhaps the difference between subethnic groups indicates the historical patterns of migration into the region. The Aku

were the last to migrate, but when they came the political differences and geographic segregation between the Huya, Djafoun, and local agriculturalists allowed the Aku to fill a market void and provide dairy products to all lowland villages as well as sell beef to Huya in Tignére. The Huya have had less of a need to undertake agriculture as they remain closer than Djafoun are to agricultural villages where they can trade. As they find permanent places to settle in the Tchabal Mbabo region, perhaps the number of them practicing agriculture will rise or they may continue to maintain a primarily pastoral life thanks to their ability to trade with local cultivators.

Very few, only 13%, of the households sold agricultural products. However, this rate is surprisingly high when one considers that most previous literature assumes that the agropastoralists grow crops primarily to supplement what they can buy and to avoid trading cattle for grain. The majority (63%) of Huya sold some sort of agricultural product, while among the Aku and Djafoun there were very little concentration on selling food crops. This difference may be related to the Huya's history in village settings where more diversified livelihoods are encouraged by the markets.

Only 8% of the households used pesticides on their fields, but the Huya were the most common users. Therefore the chi-square statistic was quite high due to differences between the groups. The Huya's higher use of pesticide may be closely related to their goals of selling agricultural products and the presence of pests in the type of environments where they settle.

There was no statistically significant difference between the subethnic groups' use of chemical fertilizer. Use was uniformly low, only 4% of households used chemical fertilizer. This is probably due to the fact that cattle manure is fairly ubiquitous and its merits as a natural fertilizer on the fields are widely recognized; whereas chemical fertilizer is an expensive and inefficient alternative for the subsistence farmer working multiple hectares without mechanization or a large potential market.

The ways in which seeds were procured by agropastoralists was significantly different. The Djafoun and Huya saved most of their own seeds. The Aku came across their seeds through markets and NGO/extension agents. Of course, saving seeds indicates an financially sound decision, but it also requires a significant investment in time and energy. In the case of the Djafoun, the ecological limits imposed by growing corn on the highest parts of the plateau means that they actually use different varieties of corn than communities in lowland areas. Due to the environment, the Djafoun get one crop a year in 5-6 months, whereas the lowland communities get two crops in the same period. Saving seeds is necessary, not just practical.

There was no difference between the numbers of hectares under production in each subethnic group. The Huya had the highest mean (4.95 ha), the Djafoun second (3.55 ha), and the Aku last with (2.69 ha). Despite these mean averages there was no statistically significant difference. Even though there was a lack of difference in field sizes, field location was highly associated with the subethnic group. The location of agricultural fields was overwhelmingly (52%) on hilltops for the Djafoun. The Aku fields were primarily in valleys, and the Huya fields were evenly distributed between hilltops and hillsides. The field distribution closely followed the distribution of home settlements.

The number of uses of agricultural extension agents (either NGO or government) over the past year was significantly different between subethnic groups. Most of the Djafoun and Akou had little interaction with agricultural extension. The Huya had the highest proportion of interactions with the agricultural extension agents. This statistic may reflect the relative remoteness of the Djafoun and the Aku's insouciance towards agriculture. The Huya are, as a group, settled closer to easily accessible locations and more concerned with agricultural production.

Methods of field preparation were significantly different between populations. Most Djafoun (73%) chose to hire labor. The Aku used primarily family labor in the fields. The Huya used both hired and family labor. It seems that the results of this analysis may be related to economic security and cultural ideals. The Djafoun often mention that their bodies are just not made for hard labor; they are made for herding cows. Therefore this statistic reflects a cultural as well as economic influence in the decision to pursue certain field preparation methods. One interesting side note is that there were no farmers using mechanized equipment and only a few Huya who had even tried animal traction.

There was a highly significant difference between fruit tree planting behaviors. Planting fruit trees reflects factors like land tenure, diversification of income, and ecological constraints. The Huya overwhelmingly (87.5%) planted fruit trees; the Djafoun (32%) planted fruit trees at a much lower rate; but the Aku (12.5%), in comparison, hardly planted at all.

In summary, of the ten NRM behaviors tested in this category, eight were significantly different and two showed no difference between subethnic groups. This suggests that there are some general differences in agricultural practices between the groups.

3.1.4 Forest Uses

Uses of the forest include direct and indirect impacts (i.e. purchase of NTFP). All the variables in this section use Pearson's Chi-square Goodness of Fit test. The first behavior considered is the purchase of fuelwood. With a p-value of 0.0547, this behavior showed no statistically significant difference between groups. The large majority of agropastoralists (88%) did not buy fuelwood and there was no difference in the proportion of purchasers in each subethnic group.

Thirty-five percent of the households planted wood for fuel or construction. There was a statistically significant difference between the subethnic groups. The percentage of Huya (92%)

who planted trees was much higher than the other groups. The Aku hardly planted any trees whatsoever (5%). This statistic's findings are similar to the fruit tree planting results found above. GGTM can use such information to design approaches to work with subethnic groups that are already involved in reforestation, to improve ongoing activities, and to control the spread of exotic species.

Bushmeat hunting is also of primary concern to GGTM. The next four questions deal with different aspects of the bushmeat trade. There was no difference in consumption of bushmeat. Although there was a significant difference between the subethnic groups in the practice of hunting bushmeat. Approximately 12% of all households consumed bushmeat. Despite this, only 3% of households admitted to hunting bushmeat. Only one Aku household admitted to hunting bushmeat. Huya were proportionately more involved with bushmeat hunting, although only 14% of them hunted. The sell of bushmeat indicates commercial activity in the bushmeat trade. Only 3 of the 202 households that responded were involved in selling bushmeat. There were so few families involved in the sale of bushmeat that their presence did not make a significant statistical difference between populations. Suffice to say that of the 124 Djafoun surveyed, none admitted to selling bushmeat. Slightly more agropastoralists (4%) were involved with the purchase of bushmeat than the hunting of bushmeat. There is a significant difference between populations as the Aku did not purchase any bushmeat, yet (33%) of the Huya bought bushmeat. The agropastoralists involvement with bushmeat beyond moderate levels of consumption is very rare. However, amongst the agropastoralists the Huya were the most involved with the bushmeat trade. The Djafoun consumed but did not hunt or sell. The Aku participated in the bushmeat trade very infrequently as consumers and sellers. The low rates of involvement in bushmeat trade reported in this survey support Vabi (1997) who concluded that most commercial hunters come from outside the immediate region.

The commercial exploitation of species like the rare *Prunus africana* is also of major concern to GGTM. The following three questions deal specifically with this species but cover other NTFP as well. There were no statistically significant differences between the subethnic groups' behaviors with regards to NTFP and *Prunus africana*. Nearly half (48%) of the households harvested *Prunus africana*. No households sold *Prunus africana*. However, 79% of the households sold some sort of NTFP (other than *Prunus africana*). Many of the herders used various woods to make bows and arrows, walking staffs, and other products which they sold in local markets. So, although agropastoralists harvest *Prunus africana* and sell some NTFP, none of the households sold *Prunus africana*. The involvement in NTFP commercialization is evident; however participation in the lucrative export markets for *Prunus africana* is not.

Other NRM behaviors important to GGTM are involvement in fishing, apiculture, and clearing forests. None of the households said that they fish or practice apiculture, so there was no need to measure the difference between the subethnic groups. However, it is interesting to note the lack of diversification in this aspect of their livelihoods, even among the Huya. There was a statistically significant difference in the number of households that had cleared of forests in the last year. Taken at the subethnic group level, the Huya were the most involved (58%) with clearing forests (in the last year) and the Djafoun were the least involved with clearing forests (18%).

In summary, the use of the forest resources by the three subethnic groups is statistically significant different for only four of the twelve measured behaviors. These four behaviors may be important to policy development since they indicate behavioral differences in bushmeat trade (buys bushmeat, hunts bushmeat), the clearance of forests (cleared forest in the last year), and the early adoption of forestry practices (plants wood for fuel or construction). However, the fact that only four of the twelve behaviors showed significant differences indicates that as a whole

forest use is similar among the subethnic groups. There is support that there are differences in forest use by the subethnic groups, however only 33% of the behaviors show any difference.

3.1.5 Animal Husbandry

Since the majority of the agropastoralists are focused on cattle raising, many of their behaviors are centered around animal husbandry. One specific aspect of animal husbandry of interest to GGTM is resource use that occurs around the practice of transhumance. Many of the questions addressed below are related to the NRM behaviors associated with the practice of transhumance.

The type of cattle breeds owned by a household reflects, among many things, the household's goals in raising cattle and the ecological parameters within which it operate. There was a highly significant difference in the cattle breeds owned by subethnic groups. The Huya own mostly mixed breeds and Gudali. They were the only group to own European, Ma'Ineeji, and Wakwa Breeds. The Aku own primarily Daneeji and mixed breeds. The

Table 3.3: Percentage of Cattle Breeds Owned by Subethnic Groups

Cattle Breed	Djafoun	Aku	Huya
Djafoun	33%	4%	0%
Daneeji	2%	46%	0%
Gudali	12%	0%	25%
Sokoto	1%	4%	0%
Ma'Ineeji	0%	0%	17%
Wakwa	0%	0%	4%
European	0%	0%	13%
Other	4%	0%	8%
Mix	48%	47%	33%

Djafoun own primarily Djafoun and mixed breeds. Of all households, 46% had primarily mixed breeds. Despite the fact that there is still a very high association of subethnic groups to cattle breed, the high proportion of mixed breeds may signify the changes in breeding goals among the

agropastoralists. Moreover, there was no statistically significant difference in the number of breeds owned by each subethnic group. In each subethnic group the mean average of the number of breeds that each household owned was approximately two. The fact that the agropastoralists in general own more than one breed implies that they are diversifying their herds in order to meet their breeding goals. This may indicate changing breeding goals or adoption of breeds better suited to their original goals. In any case, the agropastoralists' adoption of breed types had major impacts on the grazing routines, settlement locations, and other NRM behaviors. The results of this test support previous observations by Blench (1985) and Boutrais (1995).

It was difficult to get straight answers from the agropastoralists about the number of cattle they owned. Only 169 of the 205 respondents gave data on this question. However, the KW test did show a highly significant difference between the numbers of cows owned by each subethnic group. The FK test adds the caveat that the data lacked homogeneity of variances for this KW result. The mean average for the Djafoun was 142 cows, the Aku had 102 cows, and the Huya had 54 cows. The relative distribution of cows by ethnic group also heavily favored the Djafoun; the Djafoun owned 69% of all cattle. The Aku owned 25% and the Huya owned approximately 6%. The Djafoun therefore seem to own the greatest number of cows per household as well as the most cows on the plateau.

Many of the following questions center on the practice of transhumance. Transhumance routes traverse all of the regions around the plateau. The routes that traverse the northern face of the escarpment are of primary focus for conservation interests. Most agropastoralists (95%) send cattle on transhumance. Those households that did not send cattle on transhumance had very few cows so they could graze their cows on the sparse dry grass around their homesteads during the dry season. There was no significant difference in the number of participants in

transhumance between the three subethnic groups. However, below we will see how their behaviors on transhumance may slightly differ.

The amount of time that groups spend on transhumance was almost equal. The responses to this variable were in weeks. The fact that transhumance duration is controlled by seasonal fluctuation that can uniformly affect all the agropastoralists decisions probably explains why transhumance duration showed no significant difference between subethnic groups.

The distance of the transhumance was measured by using GIS functions that looked at the GPS location of households in relation to the final destinations that they stated for transhumance. There was a significant difference in the distance traveled by subethnic groups. The Aku far outpaced the rest with a mean average of 108 km. The Djafoun mean was 39 km and the Huya had 26 km. The farther distances that the Aku travel probably reflects their inability to access transhumance pastures that were previously claimed and closely guarded by Djafoun. The Huya usually send cows between relatives that live in the lowland and highlands. Thus the Huya distances are relatively short since their routes usually entail less wandering in the bush and more time around permanent settlements owned by relatives. The Djafoun and Aku descend the plateau in all directions. To the south, west, and east pasture competition with farmers and other herders is more intense than to the north. To the north, in the Dodeo River Basin, the Djafoun pasture on wild savanna and have amicable, long-term, reciprocal relationships with farming communities. The accuracy of these measures is roughly defined because of the necessity to define vague transhumance destination points in the GIS system. However, the relatively high amount of significant difference among the groups shows that such vague measurements may not have impacted the ability to reject the null, but the strength with which it could be rejected.

Many authors suggest that the routes used on transhumance are segregated by subethnic group (Boutrais 1995; Green & Tchinelé 2004; Tiayon 2004). In fact there was a significant difference in route selection. The busiest routes for all the subethnic groups were Ndogawa and Fungoi. The most numerous users on all the routes were the Djafoun, however the Aku were well represented on Ngel Aku and the Huya were well represented on the Hore Deo route. The use of the Ngel Aku route by the Aku, the Hore Deo route by the Huya, and the Yukol route by the Djafoun accounts for most of the statistical difference measured. The results of this test indicate that limiting access to some routes would disproportionately hurt subethnic groups that use that as their primary access across the northern face of the escarpment. For example, limiting access to the Ngel Aku route would put the Aku herders at a disadvantage because they would have to adopt new routes and deal with new socio-economic arrangements on a different route proportionately more than the Djafoun or Huya. On the other hand, the Djafoun and Huya routes may already be functioning at capacity and there may be a lot of conflict between the subethnic groups if there is additional pressure on the traditional routes used by a subethnic group.

Whether or not herders settle down or continue to travel during the transhumance is an important consideration that GGTM must take into account while designing programs that encourage specific pastoral management strategies. There was a significant difference between the subethnic groups' ability to settle in one destination for transhumance or their need to continually move. The Djafoun and Huya generally stayed in their destination location for the duration of the transhumance. The Aku were forced to be more mobile, probably due to the lack of agreements with local farmers not already engaged with Huya or Djafoun.

There was a highly significant difference in the groups' choices of transhumance end destinations. The majority of Djafoun went to Dodeo River, Kinel, or regions to the south of

the plateau. The Huya mostly went south to other regions or used Mayo Lelewal. The Aku, on the other hand, were forced to move primarily to the south and not spend the dry season on the plateau. This variable may again be the result of the regional “temporal hierarchy” that finds Aku with less direct access to pasture resources.

Waldé, as explained above, are herder camps that are used every year during the dry season. Ownership of *waldé* on the northern face of the escarpment is an important variable in determining who has de facto or traditional rights to grazing areas in the immediate vicinity. Interestingly, ownership of *waldé* was not different between the populations. Only 18 households were identified as owning *waldé*. The majority are owned by Djafoun, but a few are owned by Huya and one by an Aku household. Perhaps the generally low number of owners and the fact that each group has at least one owner influenced the test so that it could not reject the null. Despite the result of the test, the number of *waldé* owned by the Djafoun (13) indicates that efforts to limit access to, change the location of, or otherwise manage the areas around *waldé* on the northern face of the escarpment would more affect the Djafoun households.

The type of groups that go on transhumance can be summarized as solitary sons, hired herders, subdivisions of the family, or an entire family unit. The demographic that is sent on transhumance is important in understanding the role that transhumance plays within the family’s division of labor and to know what sort of resources can be provided to human populations that endure the transhumance. There was a significant difference between the types of groups that different subethnic groups sent on transhumance. The Djafoun sent mostly solitary sons or nephews (i.e. perhaps a relative who has lost his own cattle and will work for his relatives to reconstitute his herd) with the herds. The Aku often sent subdivisions of the family, perhaps a younger son *with his wife and child*. The Huya relied mainly on their sons and their ability to send

cattle to relatives in the lowlands. The Djafoun and Huya both hired some herders. The Aku never hired a herder.

Conflicts over land access are a recurring theme in regions throughout the world where cattle, farms, and wildlife compete. The next three questions address these conflicts and try to understand which groups are more prone to certain types of conflicts. This information indicates how many conflicts herders had over the past year. This information will assist GGTM in developing policy and extension approaches that focus on specific problems that groups are having. There was a significant difference in the number of conflicts that each subethnic groups had with wild animals, farmers, and other cattle raisers. However, the FK test rejected homogeneity of variance in the tests concerned with farmers and cattle raisers, so the results are not as strong as those for the wild animals. Aku were most prone to have conflicts with wild animals, farmers, and other herders.

The Djafoun had very little conflict with wild animals, probably because their ranches were located in cleared and populated pasture lands. The Huya, who focus more on agriculture and settled closer to forests, had more interaction with animals than the Djafoun. The Aku spent the most time in the bush areas grazing their cows and had the most conflict with animals. The Djafoun also had very few conflicts with farmers (0.4 per household), probably because there were very few farmers on the highland plateaus. The Huya (0.8) and the Aku (1.1) both had more conflicts with farmers. Their higher rates of conflict were probably due to their closer location to farming communities. Conflicts with other herders were about the same between the Djafoun and Huya, who averaged about 0.5 conflicts with other herders per household. The Aku averaged one conflict per household. This difference is again probably due to the “temporal hierarchy” that has made the Aku the least tenured and least stable of the subethnic groups, causing them to move into newer, fringe pastures much more frequently than the Djafoun and

Huya. The larger amount of conflicts that the Aku have in the community means that resolving local tenure and wild life issues with this subethnic group may be a priority of GGTM.

The next set of questions deals with animal ownership and indicates what type of resources (veterinary and otherwise) may be needed for development of local communities. It also indicates the relative material wealth, degree of sedentary settlement, and geographic remoteness of the subethnic groups. The ownership of fowl (mostly chickens) was found to be common across the subethnic groups. However, sheep, goats, donkeys, mules, and dogs were all found to be significantly different. The ownership of sheep and goats shows a movement away from the labor intense process of cattle production into a less demanding scale of husbandry. The Huya, with over 90% of their households owning small ruminants, were proportionately the most eager adopters of sheep and goats. The Aku (roughly 10%) and Djafoun (around 20%) households adopted sheep or goats with less vigor. There was no analysis conducted to explore the coincidence of sheep and goat ownership among households, however the adoption rates was very closely distributed among subethnic groups. The Huya are well along in the process of implementing non-bovine animal production on the plateau.

The use of donkeys is common among the agropastoralists who have no other way to transport heavy loads from villages to their homes. Over 66% of households owned donkeys. The Djafoun and Huya groups owned proportionately more than the Aku. This may reflect the inability of the donkeys to survive in lowland areas. The Aku often traverse areas that are infested with tsetse flies (*trypanosomiasis* vectors) where the donkeys may die or would require additional expense for medicines. The Huya and Djafoun live in higher areas where trypanosomiasis is less common. This factor may also affect the possession of horses. Ownership of horses was significantly different between the subethnic groups. The Djafoun and Huya both owned horses whereas such ownership was rare among the Aku. The Djafoun

accounted for 41% of all horse owners, and 69% of all Djafoun owned horses. Less than half of the Huya owned horses, which was still more than the Aku among whom only 8% owned horses. Interestingly, the association of horses to herding cattle is virtually nonexistent in this area due to the preponderance of tsetse flies. Horses are less resistant to disease and cannot go where cattle need to go.

The ownership of dogs also was statistically significant different between the subethnic groups. The majority of the Huya and Djafoun owned dogs, whereas a small minority of Aku owned dogs. This difference may be attributed to the degree of sedentary life that the households live and involvement in hunting. In conclusion animal ownership had clear differences between the subethnic groups. The Djafoun and Huya seemed to be more aligned in these practices than the Aku, with the exception of ownership of small ruminants. Ownership of certain types of animals will play a role in designing future development projects and controlling disease vectors.

The sale of dairy products is a practice that Boutrais (1995) regards as clearly the prerogative of the less Islamized Aku. Lack of participation in the dairy market is part of the complex group of factors that undermine women's power in the Islamized Fulbe households. The results of this study show a highly significant difference between the subethnic groups. The Aku households were the main subethnic group involved with the sale of dairy products; 98% of all Aku. The Huya and Djafoun had less than 10% of their households involved with the sale of dairy products. One misleading factor in this equation is that the activity measured in this question looks only at the activities of women in the primary community (the wet season base). The Huya and Djafoun herders will often barter dairy products during the dry season transhumance when they travel. In fact, selling dairy is the main source of income for most transhumant herders located within a reasonable distance to markets and villages. However,

when the Huya and Djafoun herders return to the primary (wet season) base, they rarely sell dairy products. On the contrary, the Aku sell dairy products during both the wet and the dry season. So the income from dairy products plays a much more important role in the Aku household. Virtanen (2003) and Boutrais (1991) both notice how the Aku women's role in selling dairy products to village settlements increases her power in family decisions. For example, her ability to give input on where Aku families move to during the transhumance and where they settle during the wet season is greatly enhanced. A simple summary of the situation is that the male Aku is preoccupied with herding and would like to settle as far as possible from others in order to take advantage of pasture resources, and the female Aku is responsible for selling dairy products in the markets and therefore is more interested in being within a couple hours' walk of a market or village. The ability of the Aku to be known as the unique vendors of dairy products in the region is due primarily to this wet season activity and to their breed of cows (*Daneeji*) which are specially bred to be good dairy cows.

The following cluster of questions relates to the adoption of modern veterinary techniques and the use of veterinary services by agropastoralists. These tests indicate certain behaviors that will be important in improving cattle management on the plateau. Very few agropastoralists, only 6%, do not use a chemical insecticide to protect their cattle at some point during or immediately before the transhumance. However, there was a significant difference between the subethnic groups. The majority of the nonusers are Aku, who account for 62% of the nonusers. The Djafoun and Huya are both consistent users of insecticides to protect their cattle. The disparity in the use of insecticide may be related to disposable income, interactions with veterinary extension, and participation in local organizing committees called *Groupements d'Initiatives Commune (GIC)*. The results of this test indicate that GGTM should concentrate on getting the most mobile of the agropastoralists (the Aku) to start using insecticides in order to

limit the vectors of disease transmission among cattle and between cattle and wild animals.

Boutrais (1999) studied the adoption of insecticides as well as application methods in the area around the village Tignére and found similar results.

As mentioned above, certain behaviors may be associated with the number of interactions with and acceptance of veterinary extension agents from either the government or from an NGO. There was a significant difference in the number of interactions that subethnic groups had with veterinary extension services over the last year. However the FK test found that the data lacked homogeneity of variance, so the KW test statistic may not be as strong as shown in the results ($H'=66.0946$). The Djafoun mean was 2.1 interactions per household, the Huya mean was 1.7 interactions, and the Aku mean was 0.8 interactions. Many of the extension agents were either of the Huya Fulbe subethnicity or associated with the GIC system that the Djafoun played a prominent role in introducing on the plateau. The Aku, on the other hand, had very little connection with veterinary extension provided by the government or NGOs. However, despite the limited amount of interactions with veterinary services and their low rate of insecticide use, the Aku did vaccinate their cows. There was no significant difference between the subethnic groups' practice of cattle vaccination. It was uniformly high at around 85%. However, one question that remains is if the agropastoralists follow the recommended vaccine program by the veterinary service. Many of the agropastoralists may vaccinate, but not follow the recommended program and only strategically vaccinating certain numbers of their cows once a year in order to avoid the costs incurred with full herd vaccination (about USD 0.70 per head).

Many of the behaviors listed in these data sets deal with early adoption of improved production techniques. Only 13% of all respondents planted pasture to help feed their cows during the dry season. However, the majority of the practitioners (78%) were Djafoun. Therefore, the statistical test noticed a significant difference in the practice of planting pasture.

Most agropastoralists rely on natural vegetation to feed their cows. Relatively new to this region is the purposeful planting of pasture resources. The people that are practicing this technology are early adopters who are mostly members of the GIC system. The fact that the Djafoun and Huya have started to adopt this technology while the Aku have not reflects land tenure and other issues that help GGTM identify early adopters and target groups for expanding this technology.

Of the 195 agropastoralists that practice transhumance, the majority (79%) would prefer to stop conducting transhumance and keep their cattle close to them on the plateau year-round. However, there is a difference between the subethnic groups. Among the Djafoun agropastoralists only 72% wanted to end transhumance, whereas among the Aku and Huya over 90% of households wanted to end transhumance. The difference in this case may have been caused by political maneuvering or a language barrier and not reflect the true desires of the respondents. Many of the Faranko'en Djafoun lineage were afraid that GGTM would limit their ability to use the transhumance trails and that their cattle would suffer because of this. This was part of an ongoing communication problem between GGTM and the local communities. According to my informants, other respondents generally understood the question as "if all resources were available, would you prefer to keep your cattle year-round on the plateau", whereas among the Faranko'en Djafoun the general responses indicate that this question was interpreted as part of the threat that GGTM posed to their traditional livelihoods. The reasons I believe these results may not reflect the true views of the respondents is because these responses are contrary to other trends in the data. Most of the early adopters of new technologies include significant amounts of Djafoun. Early adopters of managed pasture technology are not likely to support transhumance. Therefore, I question whether there is a truly significant difference, but accept the statistical results of the analysis of the responses. If there is truly a significant

difference between subethnic groups, GGTM can say that the Djafoun pose the most significant hurdle to ending or altering the practice of transhumance.

The *Groupements d'Initiatives Commune (GIC)* are officially recognized local organizations that have special rights in receiving funding and in negotiating with the government. The Djafoun Mbororo have recently been organized into many GICs which tend to represent one or more closely related families within a lineage. These GIC were organized with the collaboration of *Union des Groupements d'Initiatives Commune (GIC) du Comité d'Éradication de Tsé-Tsé en Adamaoua (UGICETA)*, the Ministry of Animal Husbandry (MINEPIA), and the Mbororo Social and Cultural Development Association (MBOSCUDA). The Djafoun Mbororo elites who were involved in the creation of the GIC have made GIC initiatives more acceptable to the agropastoralists than if they were proposed by outsiders. Membership in GICs reflects their origination among the Djafoun. There was a significant difference in membership in GICs that revealed the Djafoun (98%) and Huya (79%) as the most organized and the Aku (14%) as the least involved in GICs. This information is extremely useful for GGTM's extension efforts.

The number and the location of cattle sold are important indicators of involvement in cattle markets and will help GGTM design development initiatives that can be sensitive to the current economic strategies of the agropastoralists. The data on the number of cattle sold shows surprising results. There was no significant difference in the number of cattle sold over the past year by subethnic groups. These results are surprising because it is commonly thought the Huya and Djafoun are more focused on beef production than the Aku, and therefore should be selling more cows. However, the last year has been very difficult for the beef producers in the region and many agropastoralists were hesitant to sell at the low prices available in the markets. The bad market values were related to changing policies among the Central African states. Where the beef producers' cattle would usually be sent as far off as Gabon, Equatorial Guinea, and other

Central African states there were new policies that limited such export and created a glut in the local markets. The average amount of cows sold over the previous year was nine per household. This number does not include the amount of cattle that were bartered or traded with conditions among the cattle raisers. Therefore, while the market sale of cattle for export may show no differences among the subethnic groups possibly due to a lower amount of cattle sold in the bee markets, the amount of local bartering of cattle may have increased. The number of cows sold in the market is not the only indicator of trade; however it theoretically should have shown the difference between beef and dairy producers.

The choice of cattle market did show a statistically significant difference by subethnic group. The Djafoun's three most common preferences were to sell at Mbabo, Ganye, or Banyo. The Huya showed a preference for larger markets in periurban areas with Tibati, Belem, and Banyo. The Aku sold most often at Tibati, Belem, and Doulayel. Other less noted markets included Galim, Tignére, Assawe, and Mayo Baleo. Selling activity was relatively low and dominated by the Djafoun in the actual village of Dodeo. It appeared that most Djafoun who did transhumance in the area would prefer to sell a group of cattle at Ganye (Nigeria) than sell solitary cows to butchers in Dodeo. The different market emphases by the subethnic groups reveals how developing only certain markets can favor one subethnic groups economic development over another subethnic group.

One of the main concerns of GGTM is the presence of bushfires that escape into endangered Afromontane forest areas. All herders light bushfires on transhumance in order to clear paths and to stimulate new vegetative growth during the dry season. These fires generally are in lowland areas. So there was no data collected on these fires since the surveys questions were oriented more to activities on the plateau. However, information on cattle raiser burning around homesteads was collected. There was no significant difference between the subethnic

groups in regard to setting bushfire around their homesteads. This seemed to be a universally accepted method of clearing dry grasses.

Of the 30 variables tested in this category, 22 were significantly different and 8 were found to have no statistically significant difference. It appears that, in general, animal husbandry practices tend to differ by subethnic group. However, some important variables showed no significant difference. Probably most surprising is the fact that the number of cows sold was the same between subethnic groups.

3.1.6 Summary of Statistical Data

In summary, 37 of the 55 behaviors tested show statistically significant differences when compared between subethnic groups. In the first category on settlement characteristics all three variables showed differences that indicated that the elevation, topographic characteristics, and distance from settlement to forests is significantly different between subethnic groups. The category on agricultural practices showed among other things that adoption of agriculture, the choice of field location, use of pesticides, and the networks used to procure materials differ according to subethnic group. However, other behaviors, the amount of land (hectares in agriculture) and the use of chemical fertilizer, showed no difference between groups. Tests on forest uses concluded with only four of the twelve variables showing a statistically significant difference. The tests showed that the subethnic groups have different behaviors for hunting and buying of bushmeat; planting of fuelwood and construction wood; and involvement in forest clearance over the last year. The tests also showed that all the subethnic groups harvested but were not involved in the commercialization of *Prunus africana*; none of the herders practice apiculture or fishing; and the agropastoralists' involvement in the commercial bushmeat trade may vary by subethnic group but it was consistently low. The test on behaviors in the animal

husbandry category revealed that 22 of the 30 behaviors show statistically significant differences. The tests showed differences in the breed and number of cattle owned, the general geographic region and type of movement herders undertake during the transhumance; the amount of conflict that the agropastoralists are involved in; what type of domestic animals are owned; the adoption of more modern veterinary techniques; and the household's involvement with the sale of dairy products or specific cattle markets. Among the behaviors which showed little variation between subethnic groups were the diversity of herds; the widespread participation in transhumance; the common ownership of chickens; the common vaccination of cattle; the low number of cattle sold last year; and the use of fire to clear around homesteads.

The behaviors chosen for each of the four above categories were by no means comprehensive representations of behaviors associated with settlements, agriculture, forest use, or animal husbandry. These behaviors were analyzed because data were available from the survey. They have been extracted from available data and analyzed in order to see if there are differences in the ways that subethnic groups practice NRM to the extent that these variables represent larger behavior patterns. If each category is separately evaluated, it appears that settlement choices, agricultural practices, and animal husbandry can be considered to be different between subethnic groups. There were very few differences in the forest use behaviors of subethnic groups. However, the forest use behaviors that were different were important to GGTM: tree planting practices, bushmeat trade, and involvement in clearing forests.

Eight of the nine behaviors previously cited by other authors as showing differences by subethnic groups were verified in this study. Only one of these behaviors was found to lack significant variability by subethnic group. The eight variables that did show differences were: breed of cattle owned, transhumance routes used, insecticide use, practices agriculture, location of agricultural fields, method of field preparation, elevation of settlement, and location of

settlement. The one behavior that failed to vary by subethnic groups was “hectares used for agricultural land”. Thus, previous literature, although usually based only on anecdotal observations, was generally supported by these research findings.

3.2 Descriptive Depiction of NRM Activities

The below descriptive depictions of the subethnic groups’ NRM behaviors explores the complexity of the relationships between the statistical behaviors tested above and attempts to incorporate a more holistic picture of the role of NRM behaviors in the daily life of typical subethnic group representatives. This section does not cover all aspects of NRM among the groups, but it looks at specific behavior patterns and how that might affect the design and implementation of policy by GGTM. These depictions are based off of the 20 months of participant observation in the field.

3.2.1 Huya Fulße

As mentioned above, the Huya Fulße subethnic group includes the first lineages to truly settle the Adamaoua Plateau. Their settlement in this region implanted the currently dominant cultural, economic, and social paradigms. Below I have included additional information about typical Huya households’ NRM behaviors that did not figure into the statistical tests, but resulted from participant observations.

An important influence on Huya NRM behaviors is the ubiquity of their presence in both rural and urban spheres. Huya families generally have a network that involves both rural, village, and urban components. The Huya do not enjoy the cold temperatures of the highest peaks of the plateau. The large majority of Huya on the plateau feel that they will only briefly settle in these high elevations to recuperate their herds after catastrophic losses in the lowlands.

Nevertheless, some Huya have permanently settled on the plateau in order to make money as merchants and Quranic teachers. The Huya relatives based in villages and cities give the rural Huya an immediate access point to urban areas and markets. This is one advantage the Huya have that the Mbororo subethnicities do not have. For example, many of the Huya on the Tchabal Mbabo plateau have spent time in villages and then moved out to the plateau with the intent of building their or their family's cattle wealth. One or more brothers in their network may work in an urban or village area for the government, as a merchant, as a religious cleric, or for the Lamido. These village and urban brothers are networked into the political and market systems. The rural-based brother takes care of all the village and urban brothers' cows. The rural, village, and urban Huya tend to form cooperative networks. The rural Huya allow the urban Huya to stay involved in cattle raising, which is the cultural ideal and is considered the most reliable wealth building strategy in the region. The urban Huya provide the rural Huya with access to political, economic, and cultural institutions that the Mbororo have more difficulty accessing.

Although the number of cattle owned by Huya is lower than the Djafoun and Aku groups, it is still a large number. The Huya have, due to historical trends become the most sedentary and least pastoral of the agropastoral groups in the Tchabal Mbabo region, but they still raise significant numbers of beef cattle. The Huya tend to sell their cattle in the larger regional markets because they are well connected by the urban and village components of their family network.

A typical Huya settlement may be located at any elevation and interspersed between Djafoun, Aku, or local agriculturalists. Due to historical influences, most Huya are located at the extreme eastern and western ends of the plateau. They are common in the western part of the plateau near Fungoi, Hore Mayo Selbé, and Mayo Kelélé and scattered throughout the eastern

end of the plateau near Mbabo village and Hore Garbaya. These regions fall under the lamidates of Banyo and Tignére, who have encouraged the migration of pastoralists where the Djafoun refused to settle or pay taxes to the lamidates. Huya settlements often consist of two or three family units that work together to manage fields and cattle. Settlements are generally as close to a stream or river as possible. A Huya household is commonly found on a hillside. Below the settlement there will be approximately nine hectares of fenced agricultural fields next to water. Above the settlements cattle graze towards the hilltops where there is more wind and pasture and less chance of impingement on the agricultural fields. The Huya are intimately involved with deforestation of gallery forests in the Afromontane area due to their desire to open up land next to rivers for agricultural production. They will often practice slash and burn in the gallery forests. The Huya, because of the locations they choose to settle and their economic emphasis, produce more food crops than the other agropastoralists.

Although the Huya are generally thought to keep more land in agriculture than the other agropastoralists, there is no statistical difference to support that theory. Despite the fact that they have the same amount of land, their productivity is commonly noticed to be higher than the other agropastoralists. One reason their productivity may be higher is that they settle at lower elevations (where climatic conditions are warmer and favor more rapid growth) than Djafoun and they have more agricultural experience than most of the Aku agropastoralists. Also, the Huya take advantage of agricultural and veterinary extension services more than other agropastoralists because many extensions agents are Huya. The subethnic connection to extensions agents is a source of trust that the Djafoun and Aku do not have with the same extension agents. Again, the Huya connections to relatives in more urbanized areas allow them to have relatively easy access to markets, pesticides, seeds, and information. Although, the Huya do save their own seeds by selecting ears from stems of maize that appear most healthy and have

at least 3-4 ears per stem. The Huya have more access to agricultural technologies and settle on the most productive soils more often than the other agropastoralists, thus their productivity often surpasses the other subethnic groups.

Besides being more agriculturally productive, the Huya are also far more agriculturally diverse. Besides maize, the Huya also grew plantains, potatoes, many types of greens (like *lalo* and *kumbi*), and other species that were not found on Djafoun or Aku farms. The Huya are much more open to new additions to their diet and to experimentation with new crops.

The Huya rely on forest resources for fuelwood, medicines, bushmeat, and some NTFP. However, their connections with urban Huya often allow them to receive material goods from relatives in Banyo or Tignére. Often they will have framed beds, wooden shelves, pots and pans, medicines, and other goods from urban areas in their homes. The Huya still collect NTFP for medicines, but do not make as many products as the other subethnic groups. For example, the value of tree fibers for cordage is still very high among the Aku, but the Huya are more likely to have synthetic ropes from urban areas. The Huya do not participate in the sale of endangered flora (like *Prunus africana*), however they consume bushmeat with the exception of wild pigs, warthogs, and most birds. When the Huya sell bushmeat it is usually to visitors. They do not go out of their way to get bushmeat to market. In fact, the main way they procure bushmeat is by killing animals that enter into their maize fields. Homemade guns are occasionally found, but the main method of bushmeat hunting is still poisoned arrows. The arrows are commonly poisoned with snake venom and purchased in local markets from ethnicities that live in lowland areas and engage in more hunting activity. As mentioned above, the Huya are responsible for a large amount of the current deforestation of gallery forests, but they also plant trees for fruit, fuelwood, and construction materials more than the Aku and Djafoun. Their net effects on forest cover and ecosystem health is usually negative. They are at the frontier of deforestation

and may have negative impacts on watershed health due to their practices of slash and burn and the location of their fields and homes which can compromise water quality. Unfortunately, there have been no studies on watershed health or how the practice of upland agropastoralists affects watershed health in this region.

There are many differences between the Huya and the other agropastoralists in their practice of animal husbandry. The species composition of Huya household is more diverse. Typically Huya households have all types of animals, where Djafoun and Aku only have cattle, chickens, and donkeys. Some differences in animal husbandry of the cattle that have already been mentioned are that Huya cattle breeds are usually better for beef production and Huya own less cattle than their subethnic counterparts. Even though the number of cattle owned by Huya is smaller than the Aku and Djafoun, the Huya must still send cattle on transhumance in order to find edible grass during the dry season. Typically, just after the maize harvest, as the grass supply dwindles, cattle are allowed onto agricultural fields to eat the post-harvest stover and manure the fields. By October or November the cattle leave for transhumance with sons or hired herders. The Huya often send only one herd which goes to a single location. If the cattle are with sons they are usually being led to a relative's home in a lowland area where fresher grass is available during the dry season. If a hired herder takes the cattle then there is usually more movement involved where, for example, a herd may spend part of the dry season pasturing in Mayo Lelewal, then another period grazing somewhere near Mayo Yim, and finish with a brief sojourn in Badjara. Huya herds usually go south of the plateau and do not pass through the northern escarpment. I saw no evidence of Huya in the Dodeo River Basin grazing area to the north of the escarpment. However, the Huya herds may very well pass through this region on their way farther north. The Dodeo River Basin is the main passage to markets in Ganye, but Huya usually prefer large markets to the south of the plateau.

Like many other agropastoralists, the Huya cited many dangers and expenses that the cattle must overcome during the dry season. The Huya, like all the agropastoralists, take many precautions that their cattle do not fall ill during transhumance. However, one main difference between the Huya and the other herders is that where the Huya rely on insecticides and vaccinations, other subethnic groups might rely more on their knowledge of an area, robustness of a breed, and the skills of a herder to identify hazards. The Huya apply insecticides before transhumance, during transhumance, and before returning to the plateau. One reason that Huya apply insecticides more liberally than the other subethnic groups is that the Huya hire herders more often than other groups. The higher use of insecticide among the Huya could be interpreted as a way for the cattle raisers to insure their investment under the hired herder's care. The Huya generally do not wish to continue transhumance, but they continue because they must in order to find dry season pasture resources. Transhumance is not only dangerous for the cattle, but it also cripples a household's ability to access money through quick sale of appropriate cattle. In order to explore other management possibilities, the Huya have started to plant experimental pastures to see how *Bracharia* grass and various legumes grow near their settlements

Huya uses of fire and participation in GICs shows a difference from other groups. The Huya, like all other agropastoralists, use fires to clear land and encourage grass growth during the dry season. The Huya use of fires in a slash and burn system is one difference in the systems used by Djafoun and Aku. The Djafoun have used the GICs to do training on proper ways and times to burn the grasses on the windy plateau. However, the Huya only participate in GICs to a limited extent. Usually GICs are considered to be ways to express grievances to the government rather than ways to organize education and community activities. As mentioned above, the Huya already have social connections to government posts and access to political power, so their use

of GICs does not necessarily offer them any competitive advantage (as GICs do for the Djafoun).

The Huya do not usually sell any dairy products in the local markets. The very Islamized Huya do not consider it proper to let their wives go to market. These traditions have also become part of the Djafoun understanding of social propriety. The Aku women often take advantage of this situation and sell in markets or in village where there is no competition from other subethnic groups. One interesting result of the Huya focus on agriculture and beef cattle production is that some Huya households must trade for dairy products during the dry season and wet season because they do not produce enough.

In summary, the Huya's agricultural practices, use of fire, occasional participation in bushmeat trade, market interactions, and herding practices are all areas wherein they express unique behaviors that must be carefully observed. These unique behaviors can be used to benefit the design of improved facilities at transhumance destinations, to inform agricultural and veterinary extension, to attenuate damage to economic and social networks as changes are made in herder hiring practices, and to predict possible inconsistent benefits derived from policy that change NRM behaviors and limits access to some resources.

3.2.2 Djafoun Mbororo

The Djafoun Mbororo migrated to the Adamaoua plateau in the post-jihad period to become the first permanent settlers on the Tchabal Mbabo highlands. The Djafoun developed NRM behaviors that reflect the unique position they found themselves in politically, economically, and ecologically. The Djafoun, with whom I am more familiar than the Aku and Huya groups, most

clearly revealed in my research how even the lineages were as strongly associated with NRM behaviors as subethnic identities.

The typical Djafoun household is located in the highest areas (above 1800 meters) of Tchabal Mbabo. The main body of Djafoun settlements covers the middle of the plateau from Tchabal Kessé in the east passing westward through Mbabo and Mbontodjé and on to Tondé Wandou. Although there are many lineages in the highlands, the most numerous lineages of Djafoun are the rival lineages of Gosi'en and Faranko'en. The Faranko'en are settled near Mbabo village. The Gosi'en are heavily settled in the Mbontodjé I and II regions. The Gosi'en were the lineage to whom the lamidate of Lompta was given. They are one of the most populous lineages on Tchabal Mbabo and in the grasslands near Sabga in the Northwest Province of Cameroon. The Gosi'en often travel back and forth between Tchabal Mbabo and Sabga. They trade cattle with their relatives in these other regions to improve breed genetics and setup a social network that can cushion catastrophic animal loss to disease in a localized area. Some of the most progressive members of this lineage were ones who were exposed to new ideas in Sabga (where there are many development projects). The ideas and an attitude of experimentation have come to Tchabal Mbabo through the constant interchange of people and resources in these sister Djafoun communities.

Historically and currently, Djafoun usually are found on hilltops where they also setup their agricultural fields. Despite statistical proof of this historical fact, there seems to be a general trend of Djafoun moving down the hillsides to be closer to streams. I noticed that a preponderance of Gosi'en were no longer living on hilltops, but were moving into stream areas in order to practice agriculture at a larger scale. The Gosi'en lineage often had much larger farms than the Faranko'en who remained hilltop dwellers. The Gosi'en had more diverse animals and agricultural crops on their farms than the other lineages. They readily adopted improved pasture.

It was the Gosi'en who introduced Eucalyptus to the plateau some 15 years prior. The Gosi'en lineage was the only Djafoun lineage to send children to school and even university in the last 20 years. Therefore the Gosi'en now constitutes a new sort of elite among the Djafoun Mbororo. The Gosi'en were the first to organize GICs among the Djafoun. The Gosi'en elites who had studied at westernized schools (and even received PhD's from universities in France) were the best connected with governments and NGOs, while the Faranko'en and other lineage still had very little interaction with the mainstream Cameroonian society. In many characteristics, the Gosi'en seemed to be headed more towards a Huya lifestyle than the Faranko'en and some other lineages.

More interesting characteristics that describe this divide between the Gosi'en and the rest of the lineages are that the Gosi'en lineage vaccinated their cows more readily, were the main vendors of improved veterinary medicines, and that the elites led the somewhat unsuccessful government campaign to eradicate tsetse flies in the region. Ecologically, the incredible difference in the amount of erosion and the species composition in the pastures around the Faranko'en and the pastures near the Gosi'en led the Gosi'en to erect fences around the Mbontodjé area to protect their better pastures from Faranko'en who have lost probably 20-30% of the total grazeable area in their land around Mbabo to erosion.

The Gosi'en are also the only Mbororo group to show a significant amount of diversification of income. They have diversified their rural households and begun to create networks of educated elite in the cities. They are the prime dealers of sapphires in the Tchabal Mbabo region. The Gosi'en youth have noticed the degradation of pastures and the lack of more areas to emigrate to or expand their pastures. The common sentiment is that Tchabal Mbabo was the last place for Djafoun to go for pasture, the "last pastoral refuge" (Boutrais 1995). The regions around this area are rife with conflict and disease. In fact, when worried about whether

GGTM would force the cattle owners to evacuate the area, they often asked “Where do we have left to go? It is illegal for us to go to the Vina district (near Ngaoundéré) and all the pasture is already taken to the north.” There was a feeling that pastoralism as the elder generation knew it was near its useful end for a large majority of the youth. Therefore those that have stayed on the plateau are talking about adopting small ruminants and improved pastures. Others look even further into eco-tourism, mining, and other industries. The differences in NRM behavior and the social manifestation of these choices especially among the youth of the Gosi'en and the other lineages of Djafoun Mbororo are numerous and qualitatively important.

Despite the many differences in NRM behaviors involved with settlement locations, agriculture, and herding on the plateau, it appears that most Djafoun Mbororo lineages practice roughly the same behaviors on transhumance and in forest uses. Most Djafoun send their cattle with solitary sons on transhumance. The Djafoun are the heaviest users of the transhumance routes through the forested northern face of the escarpment and they constitute the majority of herders in the Dodeo River basin. Their herds usually stay in one place on transhumance. Either the herds stay at waldé scattered throughout the northern face of the escarpment or they stay on one or two farmers' fields in the Dodeo River basin. The herders setup temporary dwellings made from dried grasses and branches. The herders in the Dodeo village area are sometimes accompanied by a young wife and they setup their temporary huts on the agriculturalists' fields where their cows graze stover and manure the land. But in other areas like Kinel or Badjara where the terrain is rough, the boys are usually alone with the cows in their temporary dwellings on top of hills. The cows gather at night around near the herder's hilltop perch, but are often left to graze freely in the surround hills during the day.

The Djafoun sell their cows to middlemen in Mbabo. They also sometimes lead their cows north to Ganye (Nigeria) for market. Their participation in the Ganye market is economic

and cultural. Ganye is located on the road to the region where Djafoun claim their ancestors came from (Bauchi). When crossing at the Nigerian border is difficult due to political or other causes, cattle markets to the south are more utilized. Occasionally young herders will take large groups of cattle hundreds of kilometers to the south of Banyo, to Bafoussam, Bamenda, or even the coastal port Douala, in order to get a premium price for the cattle. Often these youth will return with the equivalent of thousands of dollars in cash to reconstitute a new herd. This has led to the reputation of the rich herder traveling alone on the roads and contributes to spates of road bandits in the area. The choice of market location may impacts even the rate of violent crime in this region.

Despite their adoption of many new agricultural and herding techniques, the Djafoun still refuse to use cattle for animal traction in field preparation. The Djafoun often consider it cruel to yoke their animals. The often stated that the cow was the equivalent of their mother. One of the survey respondents said, “We drink the milk of the cattle our entire lives, since we were babies. It is our mother. How can we make our mother work in the field like that? It is dishonorable.” The Djafoun usually hire help from migrant agricultural workers who come from as far away as Nigeria to earn money working the fields of the cattle raisers. This relationship between hired agricultural workers and Djafoun cattle raisers is one of the few ways that the poorer lowland populations can access funds. There are very few employment opportunities in the lowland regions to the north where subsistence agriculture, fishing, and hunting are the main activities.

The Djafoun lineages use the forests as a source of fuelwood, medicine, walking staffs, and weapons. They do not actively participate in the commercialization or export of any species other than the trees that they use for walking sticks. They do not participate in slash and burn agriculture. In fact, the use of the cattle for manure in the agricultural fields among the Djafoun

usually meant that they never abandoned a field. Where the Djafoun practice agriculture, soil fertility rises instead of falling. Among the Djafoun on Tchabal Kessé, one family had used the same field continuously for over 40 years and it continued to produce ears of corn up to 60 cm long. Around such fields, native species of *Ficus* were used as a living fence. Occasionally, Eucalyptus groves formed one side of the agricultural fields. The Djafoun use of Eucalyptus, and that the cows do not eat it, has contributed to the invasion of the nonnative species into waterways in the central plateau area.

The more economically progressive lineages of Djafoun offer lead the other lineages in adoption of new technologies. The Faranko'en did not decide to experiment with improved pasture until they saw that the Gosi'en were experiencing some success. Collaboration with the Djafoun Mbororo's more progressive lineages will possibly facilitate the entire subethnic group's adoption of new NRM behaviors. It is incredibly important for GGTM to note that gaining a foothold among the rest of the recalcitrant and reticent Djafoun Mbororo lineages will be nearly impossible without the assistance of the more progressive lineages.

3.2.3 Aku Mbororo

The Aku Mbororo were the last subethnic group to migrate into the Tchabal Mbabo region. They have maintained a more pastoral lifestyle than the Huya and the Djafoun. Part of the reason they have been able to do this is that the Djafoun communities developed a level of animosity with the local agricultural communities and the powerful Huya limiting the cattle raisers' interaction with other populations. The Aku bridged that gap by settling in close proximity to Huya and agriculturalists, interacting within the markets more, and because their migrations were largely sheltered by the colonial administrations. One result of the colonial administration supervision of the Aku migrations is that the Huya lamidates could not impose

such heavy taxes on the Aku as they had on the Djafoun. Moreover, there was no violent history of conflict that followed the new agropastoralists into the Adamaoua. With their more robust breeds, the Aku began to graze in areas that were recently cleaned of but still high risk for tsetse fly infections or in places that the Djafoun would traditionally use for dry season pasture. The rapid migration of Aku into the region necessitated that they graze in marginal areas. The earliest Aku were settled in the Doulayel area, but subsequent migrations moved up the sides of the Tchabal Mbabo highlands where they continue to create upward pressure on the Djafoun herders in the highest regions. Ironically, having filled the market voids by interacting with the Huya and local agriculturalists and using marginal areas more than the Djafoun, the Aku also are more prone to conflict with other pastoralists, farmers, and wild animals.

The Aku differ from the Djafoun and Huya in that tenure and stability have been more elusive for these latest immigrants. The major differences between the Aku and other populations revolve around agricultural practice, details of the transhumance, and settlement characteristics. The Aku are adopting more agricultural practices as they stabilize tenure in the regions surrounding the plateau. However, when they practice agriculture it is still at an entirely different level from the productive fields of the Huya or the progressive Djafoun lineages. The Aku farm only to supplement their food resources and to avoid selling cattle.

Like the other populations the Aku use the forests for medicine, fuelwood, and some NTFP. The Aku are not very involved in bushmeat trade except that when they find or kill an animal they will try to sell it. Their use of fires is largely limited to the lower echelons of the highlands and does not pose as much trouble to the gallery forests and Afromontane forests as the Huya and Djafoun fires do. However, the Aku are probably the most responsible for the setting of bushfires in the lowlands. The Aku rely mainly on a repository of bush medicines to cure their cattle. The Aku do not rely on extension services very much due to their movement

and the lack of ethnic bonds with extension agents. Despite this they do receive seeds from agricultural extension and some of them vaccinate their cows regularly.

The Aku's sources of income are not very diverse. The Aku's main source of income and food are the dairy products their cows produce. This specialization may help them avoid adopting more intense agricultural practices for a while longer in the future, but it seems that they are moving towards more sedentarization. It seems that the degree of sedentary lifestyle that a household adopts, the more it diversifies its income sources. Although the relationship between income diversification and sedentarization could be the result of participation in the beef markets, so the Aku's continued participation in and monopolization of dairy markets may limit the immediate amount of diversification they undergo.

The Aku conduct transhumance just as the other subethnic groups do, however they go farther, move more frequently, and they apply less insecticides than the other subethnic groups. They use different routes (Ngel Aku) through the northern face of the Tchabal Mbabo escarpment than other groups, but in general they migrate to the south and east of the Tchabal Mbabo highlands. Many go towards Tignére and descend the cliffs towards Mayo Baleo, and many others go south of Banyo and towards Tibati. The Aku also tend to move as family units, husband, wife, and children all walk together and establish semi-permanent dwellings outside of villages for a matter of months. Some of these temporary settlements have turned into permanent settlements around place like Tignére, Hore Garbaya, Hore Djem, and Mayo Dankali. The survey found one Aku respondent who claimed to own a waldé on the northern face of the escarpment. The field team that covered all the trails in this region found no such waldé. All waldé documented in the field were owned by Djafoun or Huya.

The breed of cattle that the Aku use (Daneeji) is well known to be hardier to insects and one of the most opportunistic grazers and best browsers of all the local breeds. The breed eats

many species, but when presented with pasture it eats low to the ground and often kills grasses by overgrazing. As the Aku move up the hillsides, locals say, the hillsides erode behind them. As well, the Aku breed may be one of the main vectors for reintroduction of tsetse flies. Their cattle are resistant to *trypanosomiasis* but can still carry the insects into recently cleaned areas if the cattle are not sprayed with insecticides.

The Aku are probably the odd man out on many of the NRM behaviors measured. They are also culturally and politically isolated. The Aku do not have much involvement with GICs and are probably the most isolated from real political power. Their main power lies in the number of Aku cattle raisers who continue to settle on the southern edges of the plateau and in taking over the metaphorical bridges that the Djafoun burned over the past 150 years in the area.

3.2.4 Summary of the Descriptive Data of Agropastoral Activities

The descriptive data above helps to contextualize and sometimes explain the results of the statistical tests. The statistical results should be considered in a holistic understanding of the networks and cultural institutions of which they play a role. Such a consideration will help us understand how changing NRM behaviors may affect the entire regional economy and impact specific aspects of groups' cultural heritage.

As well, statistics were not available to explore differences in NRM behaviors at the lineage level. As we argued earlier in this paper, it is a mistake to aggregate all pastoralists into one group of stakeholders assumed to have common interests. Just so, it is a mistake to think there is no diversity within the subethnic groups. In creating policy and extension approaches, such assumptions can undermine a project's efficacy and credibility.

It appears from the information above that the populations may show a significant difference in NRM behaviors, but whether those differences will continue to exist is

questionable. At the same time, we can also see that subethnic identity remains a formidable organizing force among these groups even with the amount of changes in the NRM behaviors of groups like the Djafoun who have become more sedentary and more Islamized over the past century while at the same time redefining the image of themselves and how they should interact with their environment. In other words, although changes in NRM behavior are occurring among the different groups, the new behaviors are often used to redefine the subethnic identity. A Djafoun who plants Eucalyptus, improved pasture, and grows many types of agricultural crops now says that he is protecting his true independence and living up to his responsibilities as a pastoralist Mbororo, whereas he might say the Aku are not honoring the Mbororo traditions because they are destroying pasture resources with their cattle breed. Even those young Djafoun who have taken up sapphire trading over cattle raising justify this change by their code of *pulaaku* and *baakilo*,⁴³ and continue to envision themselves as stewards of the environment and the virtues of their ethnicity.⁴⁴ Not only do ethnic identity and NRM behaviors seem to have a good amount of association in settlement characteristics, agricultural practices, and animal husbandry choices, but changes in NRM behaviors appear to an extent to be associated positively with ethnic identity.

3.3 Geographic Distribution of NRM Behaviors and Ecological Degradation

The distribution of subethnic groups was mapped in reference to vegetation types. The vegetation types indicate in what type of ecologies the subethnic settlements are found. The

⁴³ *Pulaaku* is the essence of the Fulbe culture for the Mbororo. “Pulaaku implies one can manage one's herd well. The Fullo is trained to be stoic, never to show his feelings, to even appear introverted to outsiders and to have a deep emotional attachment to cattle. He maintains his respect by keeping a distance from others. Pulaaku involves important virtues such as *mumyal* (patience), dignity and manly self sufficiency in the face of adversity, *senteende* which is modesty and respect for others, even for enemies, and also *bakkiilo*, forethought, prudence in managing his personal affairs and giving hospitality.

⁴⁴ One of the Mbororo leaders of a sapphire trading GIC in Galim attempted to refill all old sapphire mines from which his GIC bought sapphires and to plant improved pasture on top of them. Sapphire mines are usually trenches that are less than 4 meters deep.

vegetation types also indicate different levels of ecological degradation. The Aku groups were most often found in lowland areas near woodland forests. The Djafoun and Huya were commonly found on the higher areas where overgrazed *Sporobolus* savanna and Afromontane forests were located. In *Figure 3.1* the distribution of subethnic settlements in the Fungoi and Badjara region is shown. The trail shown passing through the population centers is a transhumance route called *Le Route de Fungoi*. Notice the clustering of Aku settlements in lower areas of woody savanna transition forest, *Hyparrhenia* savanna, and lowland gallery forests. The Djafoun on the other hand are located primarily on the overgrazed *Sporobolus* savanna and near Afromontane regions. The Huya (*Fulße*) are scattered through all elevations in this map.

The distribution of each subethnic group by vegetation type is shown in the tables below (*Tables 3.6, 3.6, and 3.7*). The Huya were located in transition forests where they were opening up new agricultural fields and on the overgrazed *Sporobolus* savanna where they competed for pasture with the Djafoun. The Aku were mostly located in woody savanna transition forests of marginal grazing quality but typical of their inability to access better highland pastures. They were also commonly found in the overgrazed *Sporobolus* savanna. The Djafoun are, obviously, heavily settled in regions of overgrazed *Sporobolus* savanna. However they are also settled close to Afromontane gallery forests where many of the agropastoralists seem to be moving for the better agricultural productivity. The distributions below indicate the common occurrence of agropastoralists in severely degraded pastures and woodland areas near streams (gallery forests in both lowlands and Afromontane areas).

Distribution of Ethnic Groups by Vegetation Type in the Fungoi-Badjara Area

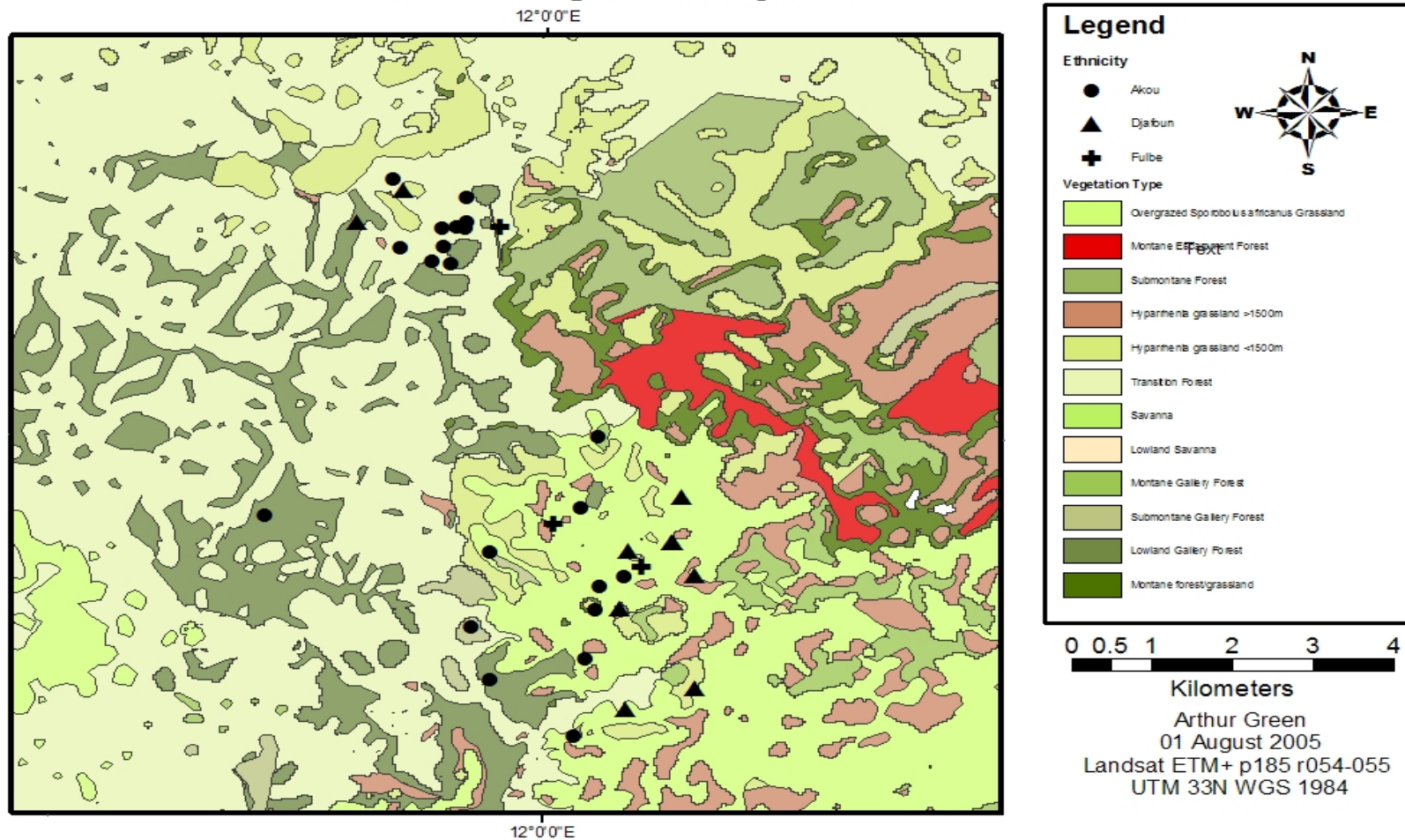


Figure 3.1: Ethnic Distribution by Vegetation Type in the Fungoi and Badjara Areas

Table 3.4: Huya Distribution by Vegetation Type

Huya Distribution	
Hyparrhenia savanna	1
Montane gallery forest	3
Overgrazed sporobous grassland	10
Woody savanna transition forest	10

Table 3.5: Aku Distribution by Vegetation Type

Aku Distribution	
Hyparrhenia Savanna	1
Lowland Gallery Forest	5
Montane forest grassland ecotone	1
Montane gallery forest	4
Woody Savanna Transition Forest	31
Overgrazed sporobous grassland	15

Table 3.6: Djafoun Distribution by Vegetation Type

Djafoun Distribution	
Hyparrhenia savanna	11
Lowland gallery forest	2
Montane escarpment forest	1
Montane gallery forest	24
Overgrazed sporobous grassland	83
Woody savanna transition forest	3

other species counts. Vegetation classification at such a macro-scale does not provide enough evidence to link ecological degradation to subethnic identity or NRM behaviors.

Statistical tests were performed on the distributions in order to see if the distribution of settlements among the vegetation types showed an observed frequency rate different from the expected frequency rate if there was no association between ethnicity and vegetation type. Pearson's Chi-square Goodness of Fit Test found a highly significant difference ($<.0001$) with a test statistic of 84.5722. There is a relationship of subethnic groups' choice of settlement areas to ecological classifications.

NRM behaviors are closely associated with subethnic identity, so further tests on NRM behaviors revealed similar associations with to the charts here. In order to study the relationships here any further it would be necessary to gather more detailed data on ecological indicators such as erosion, flora diversity, and

CHAPTER 4: CONCLUSIONS

4.1 Key Research Question

The purpose of this study was to find out if subethnic identity is associated with NRM behaviors among the Huya Fulße, Djafoun Mbororo, and Aku Mbororo subethnic groups in the Tchabal Mbabo region. The ability to use subethnic categories for identification and disaggregation of stakeholders into user groups that are functionally relevant to project implementation may help GGTM develop policies that are more efficient and appropriate. It appears that subethnic identity is associated with differences in 37 of the 55 NRM behaviors tested in this study. For certain behaviors, subethnic identity can be used to disaggregate stakeholder groups into more specific user groups.

The behaviors were grouped into thematic categories to facilitate interpretation of the results. Some of these categories are more likely to vary significantly at the subethnic level (*Table 4.1*). Most of the behaviors related to settlement characteristics, agricultural practices, and animal husbandry categories are statistically different across the subethnic groups. The forest use category did not show as high a proportion of significant differences between subethnic groups. However, as

Table 4.1: Distribution of Differences in Behavior by Thematic Category.

THEMATIC CATEGORY	DIFFERENCE	NO DIFFERENCE
SETTLEMENT CHARACTERISTICS:	3	0
AGRICULTURAL PRACTICES:	8	2
FOREST USES:	4	8
ANIMAL HUSBANDRY:	22	8
TOTAL	37	18

mentioned above, the behaviors that did show differences in the forest use category are still relevant to GGTM's design and implementation of policy. Based on the thematic trends, it seems that subethnic divisions are an appropriate way to disaggregate stakeholder groups into specific user groups in the categories of animal husbandry, agricultural practices, and settlement characteristics; though for project implementation, specific behavioral differences must be considered beyond the thematic categories.

While the behaviors listed among the 55 are not exhaustive of NRM activities on the plateau, these behaviors were available from the survey data, were of interest to GGTM, and reflected observations from previous academic publications on the region. Of the 55 behaviors, nine behaviors were previously cited as being different between subethnic groups. Tests revealed that eight of the nine behaviors mentioned as different between subethnic groups by Boutrais (1995), Blench (1985), Tiayon (2004), and Virtanen (2003) had statistically significant differences (Table 4.2). Previous literature, although usually based only on anecdotal observations, was generally supported by these research findings. Beyond those nine behaviors, the development project is able to use the knowledge of *the differences and the similarities* of the entire body of behaviors tested to inform development of policy and extension approaches.

Table 4.2: Testing Behaviors Proposed by Previous Literature

BEHAVIOR	SIGNIFICANT DIFFERENCE BY GROUP?
Breed of Cattle Owned*:	YES
Routes Used on Transhumance*:	YES
Family Sells Dairy Products in Market*:	YES
Use of Insecticides on Cattle*:	YES
Method of Field Preparation*:	YES
Hectares in Agriculture*:	NO
Location of Fields*:	YES
Elevation of Settlement*:	YES
Location of Settlement*:	YES

The differences between these populations show that adoption of agropastoral livelihoods by no means insinuates homogenization of NRM behaviors or loss of subethnic identity. There are still statistically significant differences between NRM behaviors of the groups even though they may all be considered agropastoralists. Moreover, they are all in different stages of becoming sedentary, but the choices they make as they settle clearly impact natural resources in different ways and do not imply that, when settled, they will all practice NRM in the same way.

Despite opinions that changes in pastoral livelihood structures may deteriorate the boundaries of identities and the usefulness of associating these social divisions with NRM behavior, it appears that subethnic identity is still a strong socially organizing factor for NRM behaviors. In fact, NRM still appears to be similar within but not between groups. Rather than devolving or changing their subethnic identity, many of the agropastoralists recast changes in their NRM behaviors in terms of pursuing their cultural ideals in a dynamic world. This is clearly true in the previous example involving young Djafoun Mbororo who, though adopting new NRM strategies and industries like sapphire extraction, have defined their new NRM behaviors in ways that maintain their subethnic identity and cultural ideals (*pulaaku* and *haakilo*) as stewards of the pastures and lands they call home. Perhaps casting new NRM behaviors as part of their subethnic identity is part of the reason that the association still exists. While some cultural traditions and ethnic identity parameters are lost in the change of livelihoods, it seems that new ones evolve that do not necessarily undermine the strength of the ethnic institutions.

4.2 General Implications for Policy Design

The first important policy implication is that the application of uniform policy and extension approaches over monolithic stakeholder groups is not the most effective way to work with local communities. These approaches will unequally distribute resources and affect more specific user

group segments in very different ways. This is clear when looking at the NRM behaviors, development priorities, and geographic distribution of the different subethnic groups/user groups in this case study.

Another recommendation for policy development that emerges from this research is that agencies can and should use geographic distribution and subethnic distribution (when applicable) as themes of policy development and project implementation. The identification of stakeholder groups, while commendable, is not always sufficient in practice. Specifically, with pastoral groups that are undergoing a very dynamic period for both their cultural and livelihood institutions, attention to subethnic groups and geographic distribution can yield more reliable and contextualized policy design and more effective project implementation.

4.3 Implications for GGTM Management

GGTM can use these findings to design specific policies as well as approaches to agricultural and pastoral extension around Tchabal Mbabo. Each of the thematic categories can be considered, but dealing with the implications of each individual behavior and the contexts surrounding them will make these results more appropriate for policy design.

Of course, information on geographic distribution of subethnic households will illuminate how such actions impact certain groups. The results of variables in the settlement characteristics category indicate that the location of settlements in relation to watersheds as well as the geographic distribution and concentration of subethnic groups in watersheds will be important if relocation of households and their compensation is considered a priority for endangered areas.

The different patterns of NRM behavior in the subethnic groups may lead GGTM to develop agricultural, forestry, and extension policies that focus extension of new techniques on

early adopters in the Huya and Djafoun subethnic groups. GGTM may also focus efforts on ensuring land tenure for Aku herders to promote their involvement in the development project and to control natural resource use in forested areas and marginal pasture lands. Instead of focusing on animal traction and mechanization in this remote region (introducing improved technologies for field preparation) GGTM could focus on developing better labor arrangements between the lowland populations and highland cattle raisers. Use of pesticides and chemical fertilizers may be discouraged through encouragement of better use of manure in agricultural fields and promotion of integrated pest management among the pesticide users. Seed saving programs can be encouraged among the Aku, while improvement of seed storage resources may be something that the Djafoun and Huya could focus on.

Staffing of extension services should take into consideration religious and subethnic affiliations. The more the extension has in common with subethnic groups, the more likely they may be to trust the service and try new crops or adopt new technologies. Veterinary and pastoral resource education extension service could take better advantage of the GICs among the Djafoun and promote parallel systems among the Aku and Huya. Trainings on the management of fires could focus educational programs and resources on certain GICs according to the types of vegetations where subethnic groups use fires or where they travel during transhumance.

Development of markets could focus on the unique specialties of each group. The Huya involvement in niche products of the agricultural markets could be encouraged. The Djafoun and Huya may need help from extension with breeds of cows that are more productive in high quality beef, yet still incorporate desirable local traits such as disease resistance. The Djafoun may need assistance with access to local urban markets. The Aku on the other hand may focus on dairy productivity and the possibility of further commercialization of their dairy products through cooperatives. Development of certain cattle markets in the local area may benefit some

subethnic groups more than others. Such a consideration should be factored in to the final decision of how to promote productivity and equal distribution of benefits.

Protection of forest resources from extraction may consider who the *de facto* land managers are through use of the traditional *waldé* system.⁴⁵ Any protected area management might consider using these families or herders as the main eyes and ears for infractions in flora and fauna extraction in the remote regions that they have used for grazing for many years. Moreover, any possible ecotourism would need to consider these areas as cultural as well as ecological tourism sites.

Policy concerning the management of animal husbandry strategies and resources will certainly need to consider subethnic and geographic distribution trends. The improvement or limiting of access to certain transhumance trails needs to consider the different paths taken by subethnic groups. For example, if access to the Ndogawa, Yukol, and Ngel Aku trails is limited, this will cause significant problems for Djafoun who will not be able to access their *waldé*, will take longer to reach transhumance destinations, may pay more traditional taxes by passing through other lamidates, may be more exposed to disease vectors, and may incur more costs through conflict with other pastoralists. Part of the traditional management strategies of transhumance routes is that different trails have more pasture access at different periods of the dry season. Decisions to use certain routes take in to consideration many complex factors including pasture access, disease prevalence, taxes paid, possible conflicts, and so on. Changing access will cause a decrease in pasture resources as well as significantly alter the entire traditional strategy of route selection. Improvement of the main routes around over the northern face of the escarpment (*La Route de Fungoi* and *Ndogawa*) may also encourage pastoralists who have never

⁴⁵ The *waldé* system consists of small, temporary herder settlements that are used annually during the dry season on the northern face of the escarpment and is the traditional land management system wherein management responsibility of the land is assigned to the users of the *waldé*.

used these routes before to attempt to change grazing schemes. Development of pasture resources in the Dodeo River basin, like development of the trails, is one option that GGTM has thought of pursuing in order to draw some herders out of the marginal pasture areas, ecotones region, and proximity to Afromontane forests. Such a strategy may benefit only the Djafoun and still leave Aku with problems of pasture access. There are many ancillary results of changes in access to routes or pastures that will cause unequal distribution of resources among the subethnic groups and may lead to conflict between subethnic groups.

The above represent only a few of the possible policy options that would need to be considered and changes to extension approaches that should be made if GGTM decides to use subethnic divisions and geographic distribution as part of its policy design criteria.

4.4 Future Research Opportunities

The exploratory research done in this project shows that there seems to be a positive association of subethnic groups to both vegetation classifications and NRM behaviors. Some of these vegetation types indicate severe ecological degradation. However, these results obviously cannot imply directional causality between variables. They can indicate associations that should be further researched.

Since subethnic groups were geographically clustered there should be more research on whether geographic regions can explain more of the differences in NRM behaviors than subethnic identity can explain. As well, since subethnic identity is geographically clustered, it makes sense that exploratory research on the associations between the distribution of NRM behaviors and vegetation classifications matched findings from the distribution of subethnic identity and vegetation classification indicators. Since vegetation classification can only be considered as one indicator of ecological degradation, further research could use more advanced

geospatial analysis techniques and better data on ecological degradation (erosion, water quality, localized species counts, etc.) to explore the geographic relationships of NRM behaviors, ecological degradation, and subethnic identity.

Longitudinal studies would be another very practical application of this research. Future research may also use this data as a basis for longitudinal studies that explore the devolution or continuance of ethnic identities and the differences among them in relation to changing natural resource management behaviors. As well, the data on ethnic and geographic distribution of NRM behaviors should be reevaluated after a few years of project implementation in order to look at the project's true effects on demographic patterns and NRM behaviors in the region.

REFERENCES

- Agresti, Alan, and Barbara Finlay. 1999. *Statistical methods for the social sciences*. Upper Saddle River, N.J.: Prentice Hall.
- Amanor, Kojo Sebastian. 2003. "Natural and Cultural Assets and Participatory Forest Management in West Africa." Pp. 35 in *International Conference on Natural Assets*. Tagaytay, The Philippines: Policial Economy Research Institute and Centre for Science and the Environment.
- Anderson, David, and Vigdis Broch-Due. 1999. *The poor are not us : poverty & pastoralism in Eastern Africa*. Oxford; Nairobi; Athens: J. Curry; E.A.E.P.; Ohio University Press.
- Anye, Dennis. 2005. "Gashaka Gumti_Tchabal Mbabo Transboundary Conservation Project: Biodiversity of the TM Area, Cameroon." Pp. 49 in *Project Report Number: RAF/G43/A/1G/31*. Yaounde, Cameroon.: BirdLife International; UNDP.
- . 2005b. "Gashaka Gumti-Tchabal Mbabo Transboundary Conservation Project, Personal Communication." edited by Arthur Green. Raleigh, N.C.
- Azarya, Victor. 1993. "Sedentarization and Ethnic Identity Among the Fulbe: A Comparative View." *Senri Ethnological Studies* 35:35-60.
- . 1999. *Pastoralists under pressure?: Fulbe societies confronting change in West Africa*. Leiden ; Boston: Brill.
- Balée, William L. 1998. *Advances in historical ecology*. New York: Columbia University Press.
- Barnard, Alan, and Jonathan Spencer. 1996. *Encyclopedia of social and cultural anthropology*. London ; New York: Routledge.
- Bastug, Sharon. 1998. "The Segmentary Lineage: A Reappraisal." Pp. 94-123 in *Changing nomads in a changing world*, edited by J. Ginat and Anatoly M. Khazanov. Brighton, England ; Portland, Or.: Sussex Academic Press.
- Bekker, R. 2004. *Review of approaches to, and institutional capacity for protected area conservation and management: Global Experiences*. Yaoundé: BLI; UNDP.
- . 2004b. "BLI Cameroon Project Director, Personal Communication." edited by A Green. Yaounde, Cameroon.
- Bello, Issa. 2004. "Faro-et-Deo Regional Director for UGICETA, Personal Communication." edited by A Green. Lompta, Cameroon.
- Biswas, A.K. and Cecilia Tortajada. 1995. "Environmental management in Cameroon: A participatory approach." Pp. 85-86 in *The Courier ACP-EU*.
- Blench, R. 1985. *Pastoral labour and stock alienation in the sub-humid and arid zones of West Africa*. London: Agricultural Administration Unit Overseas Development Institute.
- . 1994. "The Expansion and Adaptation of Fulbe Pastoralism to Subhumid and Humid Conditions in Nigeria." *Cahiers d'Etudes Africaines* 34:197-212.
- . 1999. "Traditional Livestock Breeds: Geographic Distribution and Dynamics in Relation to the Ecology of West Africa." in *Working Paper 122 (Overseas Development Institute)*. London.
- Bocquené, Henri, and Oumarou Ndoudi. 1986. *Moi, un Mbororo : autobiographie de Oumarou Ndoudi, Peul nomade du Cameroun*. Paris: Karthala.

- BomBome, K., B. Sock, C. Manga, J. Zibi, and J. Mbiang. 2004. *Evaluation of mammalian fauna potential, habitat and socio-economic aspects of the Tchabal Mbabo region in the Adamawa province of Cameroon*. Yaoundé, Cameroon: BirdLife International; Jane Goodall Institute.
- Bonkougou, Edouard G. 2001. *Biodiversity in Drylands; Challenges and Opportunities for Conservation and Sustainable Use*. Gland: IUCN.
- Boutrais, Jean. 1973. *La colonisation des plaines par les montagnards au nord du Cameroun (Monts Mandara)*. Paris: O.R.S.T.O.M.
- . 1983. *L'élevage soudanien : des parcours de savanes aux ranchs, Cameroun-Nigeria*. Paris; Yaoundé Cameroun: O.R.S.T.O.M.; D.G.R.S.T.
- . 1984. *Le Nord du Cameroun : des hommes, une région*. Paris: Editions de l'Office de la recherche scientifique et technique outre-mer.
- . 1993. *Peuples et cultures de l'Adamaoua (Cameroun) : actes du colloque de Ngaoundéré du 14 au 16 janvier 1992*. Paris: ORSTOM/Ngaoundéré-Anthropos.
- . 1995. *Hautes terres d'élevage au Cameroun*. Paris: ORSTOM Editions.
- Botte, Roger, Jean Boutrais, and Groupe d'études comparatives des sociétés peules. 1999. *Figures peules*. Paris: Karthala.
- Boutrais, Jean, and O.R.S.T.O.M. (Agency : France). 1974. *Étude d'une zone de transhumance, la plaine de Ndop, Cameroun = Study of a dry season grazing area, the Ndop plain, Cameroon*. Yaoundé: Centre ORSTOM de Yaoundé.
- Boutrais, Jean, O.R.S.T.O.M. (Agency : France), and Projet de développement de l'élevage dans l'ouest (Central African Republic). 1988. *Des Peul en savanes humides : développement pastoral dans l'ouest centrafricain*. Paris: Éditions de l'ORSTOM Institut français de recherche scientifique pour le développement en coopération.
- Boyd, C., Roger Blench, David Bourn, Liz Drake and Peter Stevenson. 1999. "Reconciling Interests Among Wildlife, Livestock, and People in Eastern Africa: A Sustainable Livelihoods Approach." *Natural Resource Perspectives (Overseas Development Institute)* 45.
- Busch, Carol, Paul S. De Maret, Teresa Flynn, Rachel Kellum, Sheri Le, Brad Meyers, Matt Saunders, Robert White, and Mike Palmquist. 2005. "Content Analysis." Retrieved 15 July 2005 from: <http://writing.colostate.edu/references/research/content/>.
- Carley, K. 1993. "Coding Choice for textual analysis: A comparison of content analysis and map analysis." *Sociological Methodology* 23:75-126.
- . 1993. "Coding Choices for Textual Analysis - a Comparison of Content-Analysis and Map Analysis." *Sociological Methodology 1993, Vol 23* 23:75-126.
- CARPE. 2005. "CARPE Shapefile Set." College Park, Maryland: Last Retrieved August 2005 from: <http://carpe.umd.edu/index.asp>.
- Chang, Claudia, and Harold A. Koster. 1994. *Pastoralists at the periphery : herders in a capitalist world*. Tucson: University of Arizona Press.
- CNC. 1987. Cameroun National Census provided by the Sous-Prefecture of Galim-Tigné.
- Comaroff, John L. 1987. "Of Totemism and Ethnicity: Consciousness, Practice and the Signs of

- Inequality." *Ethnos* 52:301-323.
- Conover, W. J., M. E. Johnson, and M. M. Johnson. 1981. "A Comparative-Study of Tests for Homogeneity of Variances, with Applications to the Outer Continental-Shelf Bidding Data." *Technometrics* 23:351-361.
- Cunningham, A.B.; Mbenkum, F.T. 1993. *Sustainability of Harvesting Prunus africana Bark in Cameroon: A Medicinal Plant in International Trade*. Paris: UNESCO.
- Daniel, Wayne W. 1978. *Applied nonparametric statistics*. Boston: Houghton Mifflin.
- de Bruijn, M. E., and H. J. W. M. van Dijk. 1999. "Insecurity and pastoral development in the Sahel." *Development and Change* 30:115-139.
- Diallo, Youssouf, and Günther Schlee. 2000. *L'ethnicité peule dans des contextes nouveaux : la dynamique des frontières*. Paris: Karthala.
- Dickson, Barney, and Jon Hutton. 2000. "Sustainable Use, Community-based Natural Resource Management and the Incompatibility Logic." *ResourceAfrica*.
- Djieta, L. C. 2004. *Rapid survey of the butterfly community in the Tchabal Mbabo region. Unpublished report to Gashaka Gumti - Tchabal Mbabo transboundary Conservation Project*. Yaoundé: BLI.
- Dognin, René. 1981. "L'installation des Djafoun dans l'Adamaoua camerounais: la djakka chez les Peul de l'Adamaoua." Pp. 139-157 in *Contribution de la recherche ethnologique à l'histoire des civilisations du Cameroun*, edited by C. Tardits. Paris: C.N.R.S.
- Dunn, A., Mamza, J., Ananze, F. and Gawaisa, S. 2000. "Sticking to the rules: working with local people to conserve biodiversity at Gashaka Gumti National Park, Nigeria." Pp. 128-154 in *Promoting Partnerships. Managing Wildlife Resources in Central and West Africa*, edited by J. Abbot, Ananze, F., Barning, N., Burnham, P., de Merode, E., Dunn, A., Fuchi, E., El Hakizumwami, C., Hesse, R., Mwinyihali, M., Sani, M., Thomas, D., Trench, P. and Tshombe, R. London: IIED.
- Dupire, Marguerite. 1954. "Contribution à l'étude des marques de propriété du bétail chez les pasteurs Peul." *Journal de la société des africanistes* 24:123-44.
- . 1962. *Peuls nomades. Étude descriptive des Wodaabe du Sabel Nigérien*. Paris: Institut d'ethnologie.
- . 1962. *Les facteurs humains de l'économie pastorale*. Paris: Ifan-Cnrs.
- . 1970. *Organisation sociale des Peul; étude d'ethnographie comparée*. Paris: Plon.
- FAO AGL. 2000. Retrieved August 2005 from: <http://www.fao.org/ag/agl/>
- Frantz, C. 1981. "Fulbe Continuity and Change under 5 Flags Atop West-Africa - Territoriality, Ethnicity, Stratification, and National-Integration." *Journal of Asian and African Studies* 16:89-115.
- Fratkin, Elliot M., Kathleen A. Galvin, and Eric Abella Roth. 1994. *African pastoralist systems : an integrated approach*. Boulder, Colo.: L. Rienner Publishers.
- Fratkin, E. 1997. "Pastoralism: Governance and development issues." *Annual Review of Anthropology* 26:235-261.
- Fratkin, Elliot M., and Eric Abella Roth. 2005. *As pastoralists settle : social, health, and economic consequences of the pastoral sedentarization in Marsabit District, Kenya*. New York: Kluwer Academic Publishers.

- Galaty, John G., and Philip Carl Salzman. 1981. *Change and development in nomadic and pastoral societies*. Leiden: E.J. Brill.
- Galaty, John G., Philip Carl Salzman, Harold K. Schneider, Pierre Bonte, Anders Hjort, Charles Frantz, André Bourgeot, Donald Powell Cole, and Asen Balikci. 1981. *Change and development in nomadic and pastoral societies*. Leiden: E.J. Brill.
- Gans, Herbert J. 1962. *The urban villagers; group and class in the life of Italian-Americans*. [New York]: Free Press of Glencoe.
- Garson, G. David. 1976. *Handbook of political science methods*. Boston: Holbrook Press.
- GEF. 2001. "Project 1286: Transboundary Collaboration for Ecosystem Conservation: the Mountain Forests of Gashaka Gumti National Park, Nigeria and Tchabal Mbabo, Cameroon." Retrieved February 2005 from: http://www.gefweb.org/Projects/Pipeline/Pipeline_7/Concept_draft_5_Final.DOC.
- Gonwouo, N. L. and Lebreton, M. 2004. *Reptile survey of the Tchabal Mbabo area. Unpublished report to Gashaka Gumti - Tchabal Mbabo transboundary Conservation Project*. Yaoundé: BLI.
- Green, Arthur and Jonas Tchinelé. 2004. *Evaluation of Mbororo Transhumance Routes and Natural Resource Management in the Tchabal Mbabo-Dodeo Region*. Yaoundé: BLI.
- Guichard, Martine. 2005. "Friendship and Kinship: On the difference and relevance of two systems of social relationships. The case of the Fulbe societies of northern Cameroon and northern Benin." München, Germany: Max Plank Institute. Retrieved August 2005 from: <http://www.eth.mpg.de/dynamic-index.html?http://www.eth.mpg.de/people/guichard/project.html>.
- Hall, S.J.G., Blench, R.M. 1997. "Conflicts in protected areas in Africa: livestock and the conservation of the Rwenya Wildlife Management Area, northeast Zimbabwe." in *Agricultural Research and Extension Network Paper 82b (Overseas Development Institute)*. London.
- Harris, M. 1966. "Cultural Ecology of India's Sacred Cattle." *Current Anthropology* 7:51-8.
- . 1992. "The Cultural-Ecology of India's Sacred Cattle." *Current Anthropology* 33:261-276.
- Hennig, Rainer. 1993. "Rise and Fall of the Adamawa Emirate." Retrieved August 2005 from: http://www.afrol.com/archive/fulbe_adamawa.htm.
- Hollander, Myles, and Douglas A. Wolfe. 1999. *Nonparametric statistical methods*. New York: Wiley.
- ICRAF. 2005. "Prunus Net Database." World Agroforestry Centre. Nairobi, Kenya. Retrieved August 2005 from: <http://www.worldagroforestry.org/sites/treedbs/prunus/Prunus.htm>.
- Iro, Ismail. 2005. "Fulani The Characteristics of the." Washington, D.C.: The African Development Foundation.
- IUCN. 1994. *Guidelines for Protected Areas Management Categories*. Cambridge, UK and Gland, Switzerland.: IUCN.
- Kouokam, R., and Daniel Ngantou. 2003. "IUCN Waza-Logone Project: THE WAZA-LOGONE

- FLOODPLAIN." in *Interagency Report: IUCN Waza-Logone Project*. Maroua, Cameroon.
- Kouokam, R., Moritz, M., Ngantou, D. & Loth, P.E. 2004. "Conflicts and conflict management in the Waza Logone Floodplain." Pp. 69-74 in *The return of the water: restoring the Waza Logone Floodplain in Cameroon*, edited by P.E. Loth. Gland: IUCN.
- Köhler-Rollefson, Ilse. 2001. "Intellectual property rights regime necessary for traditional livestock raisers." *Indigenous Knowledge and Development Monitor Articles* 9: Retrieved August 2005 from: <http://www.nuffic.nl/ciran/ikdm/9-1/kohler.html>.
- Krathwohl, David R. 1998. *Methods of educational and social science research : an integrated approach*. New York: Longman.
- Lacroix, Pierre-François. 1952. "Matériaux pour servir à l'histoire des Peul de l'Adamaoua." *Etudes Camerounaises* 5:3-61.
- Larison, B., Smith, T.B., Fotso, R., McNiven, D., Holbrook, K. and A. Lamperti. 1995. *Surveys of selected montane and lowland areas of Cameroon: Preliminary report to WWF-Cameroon*. Yaoundé, Cameroon: WWF.
- Little, Peter D. 1992. *The elusive granary : herder, farmer, and state in northern Kenya*. Cambridge [England] ; New York: Cambridge University Press.
- VassarStats. 2005. Retrieved August 2005 from: <http://faculty.vassar.edu/lowry/VassarStats.html>
- Mayaka, T.B. 2002. "An Ecological and Economic Assessment of Wildlife use in northern Cameroon." in *MINEF, PCGBC: Parc National de la Benoue ; Plan d'aménagement et de gestion du parc et de sa zone périphérique 2002-2006*. Yaounde, Cameroon.
- McCarthy, Nancy, and Celine Dutilly-Diane. 2004. *Managing resources in erratic environments : an analysis of pastoralist systems in Ethiopia, Niger and Burkina Faso*. Washington, DC: International Food Policy Research Institute.
- Mengang, Joseph Mewondo. 1998. "Evolution of Natural Resource Policy in Cameroon." *Yale Forestry and Environmental Science*. Bulletin 102: Sangha River Region:239-248.
- Miles, Matthew B., and A. M. Huberman. 1994. *Qualitative data analysis : an expanded sourcebook*. Thousand Oaks: Sage Publications.
- MINEPIA. 2004. "Dr. Hamadama, representative of MINEPIA, Personal Communication." edited by A Green. Ngaoundéré.
- Mohammadou, Eldridge, and Bakari Yaya. 1976. *L'histoire des Peuls Férôbé du Diamaré, Maroua et Pété*. Tokyo: Institute for the Study of Languages and Cultures of Asia and Africa.
- Mohammadou, Eldridge. 1965. *L'histoire de Tibati, chefferie Foulbé du Cameroun*. Yaoundé Cameroun: Éditions Abbia.
- . 1978. *Fulbe booseere : les royaumes foulbe du plateau de l'Adamaoua au XIX siècle : Tibati, Tignère, Banyo, Ngaoundéré*. Tokyo: Institute for the Study of Languages and Cultures of Asia and Africa.
- . 1981 *L'implantation des peul dans l'Adamawa: Approche chronologique*. In: C. Tardits (ed.), *Contribution de la Recherche Ethnologique a l'Histoire des Civilisations du Cameroun*. Paris: Editions du Centre National de la

- Recherche Scientifique.
- . 1983. *Peuples et royaumes du Foubina*. Tokyo, Japan: Institute for the Study of Languages and Cultures of Asia and Africa.
- Moran, Emilio F. 1990. *The Ecosystem approach in anthropology : from concept to practice*. Ann Arbor: University of Michigan Press.
- Moritz, Mark. 2003. "Commoditization and the Pursuit of Piety: The Transformation of an African Pastoral System." Pp. 507 in *Department of Anthropology*. Los Angeles: UCLA.
- NASA. 2005. "World Wind." NASA.
- Nelson, John. 2004. "The Need to Secure Indigenous Rights and Biodiversity Opportunities." in *5ème CEFDHAC: Conférence sur les Ecosystèmes de Forêts Denses et Humides d'Afrique Centrale*. Yaounde, Cameroon.
- Neuman, Lawrence W. 2000. *Social Research Methods*. Needham Heights, MA: Allyn & Bacon.
- Niamir-Fuller, Maryam. 1999. *Managing mobility in African rangelands : the legitimization of transhumance*. London: Intermediate Technology Publications.
- Niamir-Fuller, M., and M. Turner. 1999. "A review of recent literature on pastoralism and transhumance in Africa." in *Managing Mobility in African Rangelands: The Legitimization of Transhumance*, edited by M. Niamir-Fuller. London and Rome: Intermediate Technology Publications, Food and Agriculture Organization, and Beijer International Institute of Ecological Economics.
- Njiforti, H. and N. Tchamba. 1993. "Conflict in Cameroon: Parks For or Against People?" Pp. 173-178 in *Indigenous Peoples and Protected Areas*, edited by E. Kemf. London: Earthscan.
- Noye, Dominique. 1974. *Cours de foulfouldé : dialecte peul du Diamaré, Nord-Cameroun : grammaire et exercices, textes, lexiques peul-français et français-peul*. Paris ; Maroua, Cameroun : Mission catholique.
- Noye, Dominique, Roger Labatut, and Christian Seignobos. 1989. *Dictionnaire foulfouldé-français : dialecte Peul du Diamaré, Nord-Cameroun*. Paris ; Garoua Cameroun: Mission catholique.
- Omotayo, A. M. 2003. "Ecological implications of fulbe pastoralism in southwestern Nigeria." *Land Degradation & Development* 14:445-457.
- Palmquist, M. E., Carley, K.M., and Dale, T.A. 1997. "Two applications of automated text analysis: Analyzing literary and non-literary texts." in *Text analysis for the social sciences : methods for drawing statistical inferences from texts and transcripts*, edited by Carl W. Roberts. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Patton, Michael Quinn. 1990. *Qualitative evaluation and research methods*. Newbury Park, Calif.: Sage Publications.
- Pike, Kenneth Lee. 1954. *Language in relation to a unified theory of the structure of human behavior*. Glendale, Calif.: Summer Institute of Linguistics.
- Rege, J. E. O. 2003. "Livestock breeds in traditional Animal Genetic Resources management." Pp. 133-138 in *Conservation and sustainable use of agrobiodiversity: A source book.*, edited by CIP-UPWARD. Los Banos, Laguna, The Phillipines.

- Roberts, Carl W. 1997. *Text analysis for the social sciences : methods for drawing statistical inferences from texts and transcripts*. Mahwah NJ.: Erlbaum.
- Salafsky, Nick, Richard Margoluis, and Kent Radford. 2001. *Adaptive Management: A Tool for Conservation Practitioners*. Washington D.C.: World Wildlife Fund (Biodiversity Support Program).
- Salafsky, N., R. Margoluis, K. H. Redford, and J. G. Robinson. 2002. "Improving the practice of conservation: a conceptual framework and research agenda for conservation science." *Conservation Biology* 16:1469-1479.
- Salamon, Sonya. 1992. *Prairie patrimony : family, farming, and community in the midwest*. Chapel Hill: University of North Carolina Press.
- Salzman, Philip Carl, and Edward Sadala. 1980. *When nomads settle : processes of sedentarization as adaptation and response*. New York: Praeger.
- Salzman, Phillip Carl and Donald W. Attwood. 1996. "Ecological Anthropology." Pp. 169-172 in *Encyclopedia of Social and Cultural Anthropology*, edited by Alan Barnard, and Jonathan Spencer. London: Routledge.
- Scholte, P., Saleh Adam, Saidou Kari and Jean-Hilaire Mbouche. 1999. "Walking a tightrope: using PRA in a conflict situation around Waza National Park, Cameroon." *PLA Notes (IIED London)*:7-12.
- Seymour-Smith, Charlotte. 1986. *Dictionary of anthropology*. Boston, Mass.: G.K. Hall.
- Smith, T.B., and D. McNiven. 1993. "Preliminary surveys of the avifauna of Mt. Tchabal Mbabo, west-central Cameroon." *Birds Conservation International* 3:13-19.
- Soeftestad, Lars T. 2001. "Community-Based Natural Resource Management: Knowledge Management and Knowledge Sharing in the Age of Globalization." *CBNRM Net*. Retrieved August 2005 from: www.cbnrm.net.
- Spedini, G., G. Destro-Bisol, S. Mondovi, L. Kaptue, L. Taglioli, and G. Paoli. 1999. "The peopling of sub-Saharan Africa: The case study of Cameroon." *American Journal of Physical Anthropology* 110:143-162.
- Stem, C., R. Margoluis, N. Salafsky, and M. Brown. 2005. "Monitoring and evaluation in conservation: a review of trends and approaches." *Conservation Biology* 19:295-309.
- Strauss, Anselm L. 1987. *Qualitative analysis for social scientists*. Cambridge [Cambridgeshire] ; New York: Cambridge University Press.
- Stone, Glenn Davis and Christian E. Downum. 1999. "Non-Boserupian Ecology and Agricultural Risk: Ethnic Politics and Land Control in the Arid Southwest." *American Anthropologist* 101:113-128.
- Sutton, C.S. 2005. "Some Comments about Chapter 6 of Hollander & Wolfe." edited by Class notes. Fairfax, VA: Retrieved August 2005 from: <http://mason.gmu.edu/~csutton/handwch6657.html>.
- Temu, August B., Per G. Rudebjer, James Kiyiapi and Pieter van Lierop. 2005. "Forestry Education in Sub-Saharan Africa and Southeast Asia: Trends, myths and realities." *FAO, ANAFE and SEANAFE: Forestry Policy and Institutions Working Paper* 3.

- Thomas, D., and Thomas, J. 1996. *Tchabbal Mbabo Botanical Survey: Report to WWF*. Yaoundé: WWF.
- Tiayon, Francois. 2004. *Assessing people's participation in Conservation Initiatives in the Mbabo, Dodeo, and Mayo Kelélé Areas (Adamaoua Province)*. Yaoundé: BLI.
- Transparency International. 2004. "TI Corruptions Perceptions Index." Retrieved July 2005 from: <http://www.transparency.org>.
- Turner, M. 1993. "Overstocking the Range - a Critical Analysis of the Environmental Science of Sahelian Pastoralism." *Economic Geography* 69:402-421.
- . 1999. "Labor process and the environment: The effects of labor availability and compensation on the quality of herding in the Sahel." *Human Ecology* 27:267-296.
- University of Texas, Austin. 2005. "The Perry Castaneda Library Map Collection: Map of Cameroon." Austin, Texas. Retrieved July 2005 from: http://www.lib.utexas.edu/Libs/PCL/Map_collection/Map_collection.html.
- U.S. Department of State. 2005. Retrieved August 2005 from: www.state.gov/r/pa/ei/bgn/26431.htm
- Vabi, M. 1997. *Report of project identification and familiarisation trip to Tchabbal Mbabo, community hunting group at Tibati and discussion of the execution of socio-economic surveys in the Southeast forests*. Yaoundé: WWF.
- Vereecke, C. 1989. "From Pasture to Purdah - the Transformation of Womens Roles and Identity among the Adamawa Fulbe." *Ethnology* 28:53-73.
- Virtanen, Tea. 2003. "Performance and Performativity in Pastoral Fulbe Culture." Pp. 273 in *Anthropology*. Helsinki: University of Helsinki, Finland.
- Weladji, R. B., and M. N. Tchamba. 2003. "Conflict between people and protected areas within the Benoue Wildlife Conservation Area, North Cameroon." *Oryx* 37:72-79.
- Wilcock, Samuel P. 2001. "A New Nonparametric Procedure for the k-sample Problem." Pp. 264 in *Department of Statistics*. Blacksburg: Virginia Polytechnic Institute and State University.
- Woodhouse, Phil. 2002. "Natural Resource Management and Chronic Poverty in Sub-Saharan Africa: an overview paper." *Chronic Poverty Research Centre Working Paper* 14.
- WRI. 2003. "Cameroon Profile." in *Earth Trends Country Profiles*. Last Retrieved August 2005 from: <http://earthtrends.wri.org/>.

APPENDICES

APPENDIX I: Survey Instrument

Tchabal Mbabo Natural Resource Management Head of Household Survey

Village Name:

HH#:

PERSONAL INFORMATION:

Name:

Age:

Nationality:

Ethnicity:

Family Lineage:

Education:

Place of Birth:

of wives:

of children:

of people in household (at present):

SETTLEMENTS:

Latitude (m):

Longitude (m):

Elevation (m):

Size of concession (m2):

Number of buildings:

Building materials:

Distance to agriculture fields:

Cattle overnight location in rainy season:

Cattle overnight location in dry season:

Distance to potable water:

Is the water source managed?

Distance to forest (close 200m/mid 200-500m/more than 500m):

Amount of Time in Present Location:

If newly settled, where was their previous settlement?

How did he get permission to stay here/ acquire the land?

Toilet Facilities:

DIET:

What does the family usually eat?

AGRICULTURE

1. Location of plots (Valley/Hilltop/ Forest Area):
2. Practice shifting cultivation (Y/N)?
3. When was most recent forest clearing?
4. Fencing:
 - a. Use of Fencing (Y/N):
 - b. Fencing materials used:
 - c. Where acquired?
 - d. Price:
 - e. What is inside?
 - f. What is outside?
5. Chemical fertilizer:
 - a. Use of chemical fertilizer (Y.N)?
 - b. How much?
 - c. Cost
6. Cow manure:
 - a. Use of cow manure as fertilizer (Y/N)?
 - b. When?
 - c. Does he leave stover for cows?
 - d. Whose cows come?
 - e. How long do cows stay?
7. Land preparation?
 - a. How is land prepared?
 - b. Use of animal traction (Y/N):
 - c. Why or why not?
 - d. Use of migrant laborers?
 - i. Who?
 - ii. When?
 - iii. How much paid?
 - iv. Which crops?
 - v. What duties?
 - vi. Why?
8. Does he ever consult any of below about agriculture:
 - a. MINAGRI staff:
 - b. Other government agents (Who?):
 - c. NGO agents (Which NGO?):
 - d. Local farmers (which ethnicity?):
 - e. How often?
9. Agropastoral conflict:
 - a. Most recent occurrence?
 - b. Every year?
 - c. Whose cows?
 - d. Resolution:
 - e. Story:

AGRICULTURE SPECIES TABLE:

Crops Grown	Planting	Harvest	Intercropping species:	Cumulative size of plots (estimate) (hectares)	# of Plots	Sale? Y/N FCFA earned	Age range of plots	Insect pests:	Insecticide Used: No use=0 Chemical=1 (name) Natural=2 (name) Other=3 (name)

FOREST USES

1. Hunting
 - a. Does anyone in family hunt?
 - b. What do they hunt?
 - c. How (methods)?
 - d. When is hunting practiced?
 - e. Why? Subsistence, market sell, other:
 - f. Is any bushmeat sold?
 - g. Do they purchase bushmeat?
 - h. From who is it purchased?
 - i. What kinds of bushmeat purchased/price?
2. Honey
 - a. Harvest from wild?
 - b. Bee keeping? How?
 - c. Purchase?
 - d. Who?
 - e. Price?
3. Conflict with animals
 - a. Most recent?
 - b. What animal?
 - c. Has he killed an animal in a conflict?
 - d. Story:
4. What is in the forest?
5. Are there places in the forest that are dangerous?
6. Are there places in the forest that no one will go?
7. Does the forest help you?
8. How does the forest help you?
9. Fishing
 - a. When?
 - b. Where?
 - c. What species?
 - d. How?
 - e. Purchase fish?
10. What forest products does the family purchase?
 - a. How much (quantity)?
 - b. How much (price)?
 - c. Why?
 - d. Which market?
 - e. From who?
11. Planted any trees from forest or otherwise (table)?

FOREST SPECIES TABLE:

Species	Full Name	Part : Use *	Who harvests	How much is harvested per use	Frequency of harvest	When harvested (time of year/day)	Where harvested	Planted (Y/N)	Sold ? Price per unit ?	Where sold? Buyer ?	Species	Number of Years Planted	Time to Harvest	Uses	Sold (Y/N) ? Price per unit:

*PART:

1. Leaves
2. Stem
3. Branches
4. Bark
5. Roots
6. Sap
7. Other

USE:

- a. fuelwood
- b. construction
- c. medicine
- d. bow/arrow/staff
- e. poison
- f. food
- g. cordage
- h. magic
- g. teeth cleaner
- h. other

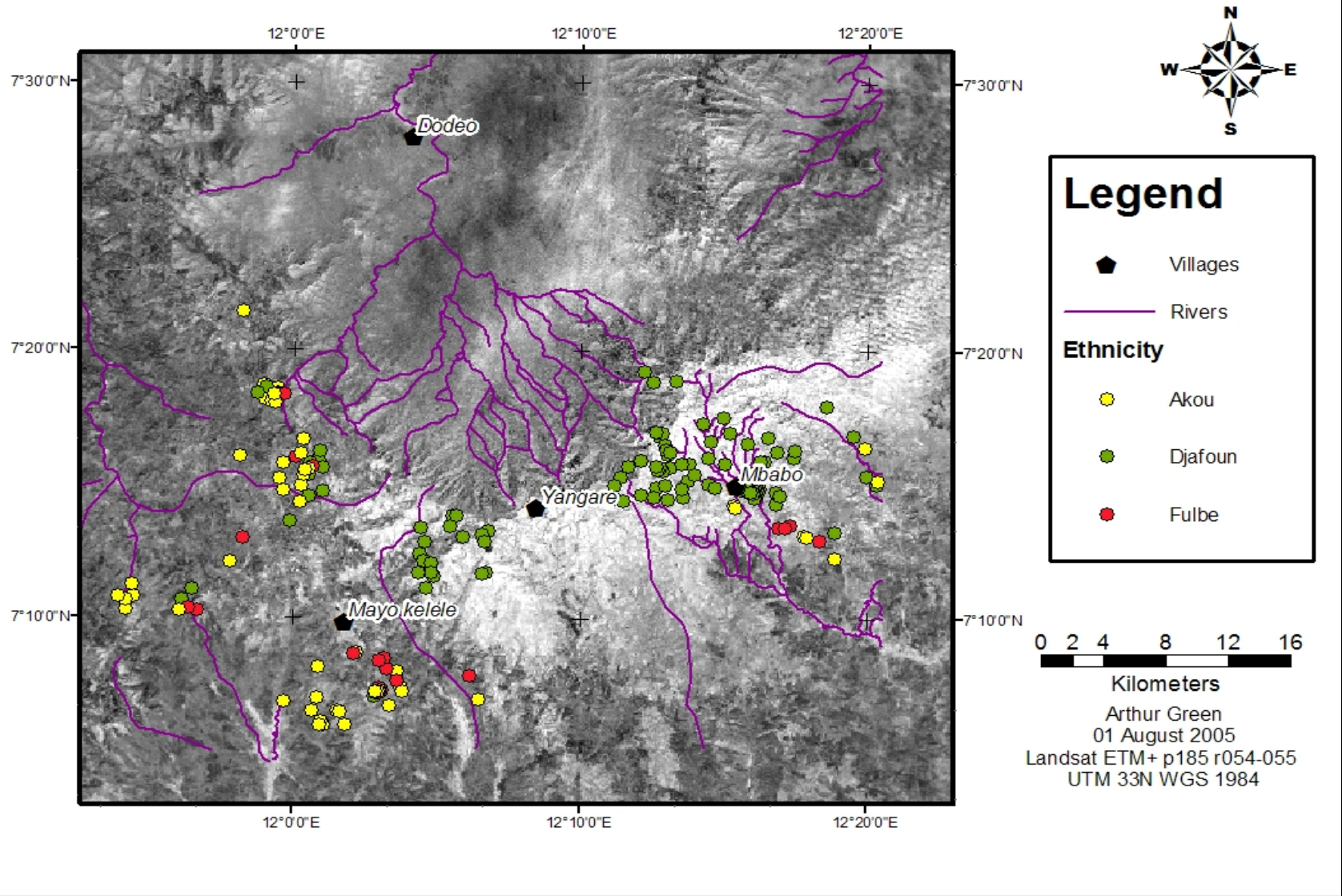
ANIMAL HUSBANDRY

1. Breeds of cattle held?
2. Breed percentage of total cattle?
3. Transhumance
 - a. Does he send his cattle on transhumance?
 - b. Does he go or send herders?
 - c. Who herds the cattle (family/hired/friends)?
 - d. Description of his herders for this year:
 - e. Species/breed sent on transhumance
 - f. Why are some cows kept from transhumance?
 - g. Number of animals sent:
 - h. Number of animals kept:
 - i. When does the transhumance begin?
 - j. How does one know to begin the transhumance?
 - k. When does the transhumance end?
 - l. Do you organize your depart with other cattle raisers/herders?
 - m. How do you decide where to go?
 - n. Is there conflict between herders over grazing areas?
 - o. Is there conflict between families over grazing areas?
 - p. Do you own *walde*?
 - q. Do you share *walde* with other people? Same ethnicity? Same family?
 - r. How long (time) is your normal transhumance?
 - s. How long (distance) is your normal transhumance?
 - t. Do herders travel fulltime or settle down in an area?
 - u. How long do they settle in one area?
 - v. If they are settled do they herd the cows or do the cows graze in proximity?
 - w. Where do they settle (near water or hilltop or other)?
 - x. What do herders eat?
 - y. With what materials do herders construct homes?
 - z. Do the herders normally travel alone, with other herders, or with wife and kids
 - aa. How much time is spent in the forests of the cliff region during transhumance?
 - bb. Where do your herds go?
 - cc. Which itinerary (series of stops to “final” destination) do the herders use?
 - dd. Do they return on the same itinerary?
 - ee. What are some dangers to the cattle during the transhumance?
 - ff. Has your herder ever had to kill an animal to protect himself or the cattle?
 - gg. What do herders do with their spare time in the bush?
 - hh. Do you or your herders have problems with farmers?
 - ii. Are these conflicts with farmers yearly?
 - jj. Are these conflicts getting worse or better compared to recent year?
 - kk. How are the conflicts resolved?
 - ll. Do you see a difference in the forests or in the waldes where cattle are herded and not herded?
 - mm. What is the difference?
 - nn. Do herders need permission to enter certain regions?
 - oo. Which regions?
 - pp. How do herders get permission?
 - qq. What sicknesses do cattle incur?
 - rr. How are the cattle cured? What is the medicine used?
 - ss. Does the herder treat the cattle with insecticides before transhumance?

- tt. Does the herder treat the cattle with insecticides during transhumance?
- uu. Why do the herders do transhumance (solicit reasons)?
- vv. Do herders take cattle together from many cattle raisers, a few cattle raisers, or just one cattle raiser?
- ww. Do herders usually own their own cattle?
- xx. How are herders paid?
- yy. Do herders open trails?
- zz. Do herders start bush fires?
- aaa. Where do herders start bushfires?
- bbb. When do herders start bushfires?
- ccc. Why do they start bushfires?
- ddd. Do herders kill birds?
- eee. Do herders kill any animals for food?
- fff. Which NWFP do herders collect to sell?

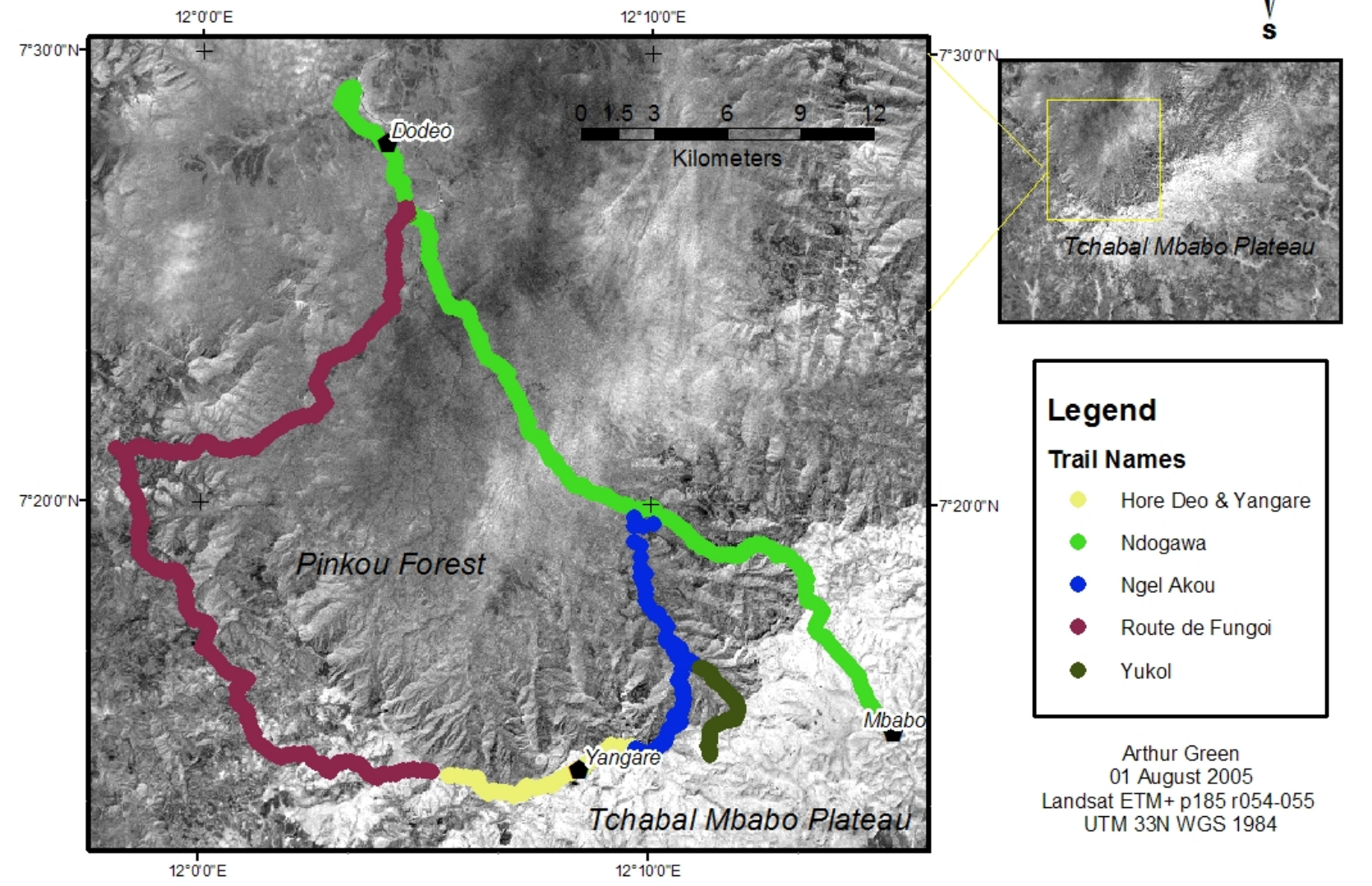
- 4. Does the cattle raiser burn pasture around the homestead?
- 5. How often?
- 6. Why?
- 7. When bushfires are started are they controlled?
- 8. How are they controlled?
- 9. Who herds the cattle at home?
- 10. Where do the cows graze?
- 11. Why are the cows kept in certain areas?
- 12. Which species, breed, gender, and how many animals are sold every year?
- 13. Where are cattle sold (which public markets or private trade)?
- 14. When are cattle sold?
- 15. To who are cattle sold?
- 16. How are human and cattle water sources managed?
- 17. Does the family share cattle with other families? Are all their cattle present or with other herders?
- 18. Why does the family share cattle with other families?
- 19. Does he vaccinate cows?
- 20. What percentage of cows does he vaccinate?
- 21. How many times a year?
- 22. Why does not he vaccinate all cows?
- 23. If he could keep all cows on Tchabal Mbabo and not do transhumance, would he?
- 24. Has he planted any new types of grasses for the cows?
- 25. What grass types?
- 26. Is he a member of any government sanctioned organization (GIC)?
- 27. Diseases affecting cattle ?
 - Pasteurellose
 - Charbon symptomatique
 - Piroplasmose
 - Distomatose
 - Trypanosome
 - Fievre aphteuse
 - Dermatose nodulaire
 - Tremblote animale
 - Peste aviaire
 - Maladies respiratoire au niveau de la volaille
 - Strongylose chez les moutons, Other, No Cattle

Distribution of Ethnic Groups Around Tchabal Mbabo



APPENDIX II: Distribution of Ethnic Groups Around Tchabal Mbabo

Transhumance Routes on the Northern Face of the Tchabal Mbabo Escarpment



APPENDIX III: Map of Transhumance Routes on the Northern Face of the Tchabal Mbabo Escarpment

I. Fligner-Killeen Test for Homogeneity of Variances

Description:

Performs a Fligner-Killeen (median) test of the null that the variances in each of the groups (samples) are the same.

Usage:

```
fligner.test(x, ...)

## Default S3 method:
fligner.test(x, g, ...)

## S3 method for class 'formula':
fligner.test(formula, data, subset, na.action, ...)
```

Arguments:

x: a numeric vector of data values, or a list of numeric data vectors.

g: a vector or factor object giving the group for the corresponding elements of 'x'. Ignored if 'x' is a list.

formula: a formula of the form 'lhs ~ rhs' where 'lhs' gives the data values and 'rhs' the corresponding groups.

data: an optional data frame containing the variables in the model formula.

subset: an optional vector specifying a subset of observations to be used.

na.action: a function which indicates what should happen when the data contain 'NA's. Defaults to 'getOption("na.action")'.

...: further arguments to be passed to or from methods.

Details:

If 'x' is a list, its elements are taken as the samples to be compared for homogeneity of variances, and hence have to be numeric data vectors. In this case, 'g' is ignored, and one can simply use 'fligner.test(x)' to perform the test. If the samples are not yet contained in a list, use 'fligner.test(list(x, ...))'.

Otherwise, 'x' must be a numeric data vector, and 'g' must be a vector or factor object of the same length as 'x' giving the group

for the corresponding elements of 'x'.

The Fligner-Killeen (median) test has been determined in a simulation study as one of the many tests for homogeneity of variances which is most robust against departures from normality, see Conover, Johnson & Johnson (1981). It is a k-sample simple linear rank which uses the ranks of the absolute values of the centered samples and weights $a(i) = qnorm((1 + i/(n+1))/2)$. The version implemented here uses median centering in each of the samples (F-K:med X^2 in the reference).

Value:

A list of class "htest" containing the following components:

statistic: the Fligner-Killeen:med X^2 test statistic.

parameter: the degrees of freedom of the approximate chi-squared distribution of the test statistic.

p.value: the p-value of the test.

method: the character string "Fligner-Killeen test for homogeneity of variances".

data.name: a character string giving the names of the data.

References:

William J. Conover & Mark E. Johnson & Myrle M. Johnson (1981). A comparative study of tests for homogeneity of variances, with applications to the outer continental shelf bidding data. *_Technometrics_* *23*, 351-361.

Fligner-Killeen Test CODE:

```
-----  
> getS3method ("fligner.test","default")  
function (x, g, ...)  
{  
  if (is.list(x)) {  
    if (length(x) < 2)  
      stop("x must be a list with at least 2 elements")  
    DNAME <- deparse(substitute(x))  
    x <- lapply(x, function(u) u <- u[complete.cases(u)])  
    k <- length(x)  
    l <- sapply(x, "length")  
    if (any(l == 0))  
      stop("all groups must contain data")  
    g <- factor(rep(1:k, l))  
    x <- unlist(x)
```

```

}
else {
  if (length(x) != length(g))
    stop("x and g must have the same length")
  DNAME <- paste(deparse(substitute(x)), "and", deparse(substitute(g)))
  OK <- complete.cases(x, g)
  x <- x[OK]
  g <- g[OK]
  if (!all(is.finite(g)))
    stop("all group levels must be finite")
  g <- factor(g)
  k <- nlevels(g)
  if (k < 2)
    stop("all observations are in the same group")
}
n <- length(x)
if (n < 2)
  stop("not enough observations")
x <- x - tapply(x, g, median)[g]
a <- qnorm((1 + rank(abs(x))/(n + 1))/2)
STATISTIC <- sum(tapply(a, g, "sum")^2/tapply(a, g, "length"))
STATISTIC <- (STATISTIC - n * mean(a)^2)/var(a)
PARAMETER <- k - 1
PVAL <- pchisq(STATISTIC, PARAMETER, lower = FALSE)
names(STATISTIC) <- "Fligner-Killeen:med chi-squared"
names(PARAMETER) <- "df"
METHOD <- "Fligner-Killeen test for homogeneity of variances"
RVAL <- list(statistic = STATISTIC, parameter = PARAMETER,
  p.value = PVAL, method = METHOD, data.name = DNAME)
class(RVAL) <- "htest"
return(RVAL)
}
<environment: namespace:stats>

```

```

-----
-----

```

II. Kruskal-Wallis Rank Sum Test

Description:

Performs a Kruskal-Wallis rank sum test.

Usage:

```
kruskal.test(x, ...)
```

```
## Default S3 method:
```

```
kruskal.test(x, g, ...)
```

```
## S3 method for class 'formula':
```

`kruskal.test(formula, data, subset, na.action, ...)`

Arguments:

`x`: a numeric vector of data values, or a list of numeric data vectors.

`g`: a vector or factor object giving the group for the corresponding elements of 'x'. Ignored if 'x' is a list.

`formula`: a formula of the form 'lhs ~ rhs' where 'lhs' gives the data values and 'rhs' the corresponding groups.

`data`: an optional data frame containing the variables in the model formula.

`subset`: an optional vector specifying a subset of observations to be used.

`na.action`: a function which indicates what should happen when the data contain 'NA's. Defaults to 'getOption("na.action")'.

`...`: further arguments to be passed to or from methods.

Details:

'kruskal.test' performs a Kruskal-Wallis rank sum test of the null that the location parameters of the distribution of 'x' are the same in each group (sample). The alternative is that they differ in at least one.

If 'x' is a list, its elements are taken as the samples to be compared, and hence have to be numeric data vectors. In this case, 'g' is ignored, and one can simply use 'kruskal.test(x)' to perform the test. If the samples are not yet contained in a list, use 'kruskal.test(list(x, ...))'.

Otherwise, 'x' must be a numeric data vector, and 'g' must be a vector or factor object of the same length as 'x' giving the group for the corresponding elements of 'x'.

Value:

A list with class "htest" containing the following components:

`statistic`: the Kruskal-Wallis rank sum statistic.

`parameter`: the degrees of freedom of the approximate chi-squared distribution of the test statistic.

`p.value`: the p-value of the test.

method: the character string "Kruskal-Wallis rank sum test".

data.name: a character string giving the names of the data.

References:

Myles Hollander & Douglas A. Wolfe (1973), *Nonparametric statistical inference*. New York: John Wiley & Sons. Pages 115-120.

Krusk-Wallis Test Code:

```
-----  
  
> stats::kruskal.test.default  
function (x, g, ...)  
{  
  if (is.list(x)) {  
    if (length(x) < 2)  
      stop("x must be a list with at least 2 elements")  
    DNAME <- deparse(substitute(x))  
    x <- lapply(x, function(u) u <- u[complete.cases(u)])  
    k <- length(x)  
    l <- sapply(x, "length")  
    if (any(l == 0))  
      stop("all groups must contain data")  
    g <- factor(rep(1:k, l))  
    x <- unlist(x)  
  }  
  else {  
    if (length(x) != length(g))  
      stop("x and g must have the same length")  
    DNAME <- paste(deparse(substitute(x)), "and", deparse(substitute(g)))  
    OK <- complete.cases(x, g)  
    x <- x[OK]  
    g <- g[OK]  
    if (!all(is.finite(g)))  
      stop("all group levels must be finite")  
    g <- factor(g)  
    k <- nlevels(g)  
    if (k < 2)  
      stop("all observations are in the same group")  
  }  
  n <- length(x)  
  if (n < 2)  
    stop("not enough observations")  
  r <- rank(x)  
  TIES <- table(x)  
  STATISTIC <- sum(tapply(r, g, "sum")^2/tapply(r, g, "length"))  
  STATISTIC <- ((12 * STATISTIC/(n * (n + 1)) - 3 * (n + 1))/(1 -
```

```

    sum(TIES^3 - TIES)/(n^3 - n))
PARAMETER <- k - 1
PVAL <- pchisq(STATISTIC, PARAMETER, lower = FALSE)
names(STATISTIC) <- "Kruskal-Wallis chi-squared"
names(PARAMETER) <- "df"
RVAL <- list(statistic = STATISTIC, parameter = PARAMETER,
  p.value = PVAL, method = "Kruskal-Wallis rank sum test",
  data.name = DNAME)
class(RVAL) <- "htest"
return(RVAL)
}
<environment: namespace:stats>
>

```

```

-----
-----

```

III. Pearson's Chi-squared Test for Count Data

Description:

'chisq.test' performs chi-squared tests on contingency tables.

Usage:

```

chisq.test(x, y = NULL, correct = TRUE,
  p = rep(1/length(x), length(x)),
  simulate.p.value = FALSE, B = 2000)

```

Arguments:

x: a vector or matrix.

y: a vector; ignored if 'x' is a matrix.

correct: a logical indicating whether to apply continuity correction when computing the test statistic.

p: a vector of probabilities of the same length of 'x'.

simulate.p.value: a logical indicating whether to compute p-values by Monte Carlo simulation.

B: an integer specifying the number of replicates used in the Monte Carlo simulation.

Details:

If 'x' is a matrix with one row or column, or if 'x' is a vector and 'y' is not given, 'x' is treated as a one-dimensional contingency table. In this case, the hypothesis tested is whether

the population probabilities equal those in 'p', or are all equal if 'p' is not given.

If 'x' is a matrix with at least two rows and columns, it is taken as a two-dimensional contingency table, and hence its entries should be nonnegative integers. Otherwise, 'x' and 'y' must be vectors or factors of the same length; incomplete cases are removed, the objects are coerced into factor objects, and the contingency table is computed from these. Then, Pearson's chi-squared test of the null that the joint distribution of the cell counts in a 2-dimensional contingency table is the product of the row and column marginals is performed. If 'simulate.p.value' is 'FALSE', the p-value is computed from the asymptotic chi-squared distribution of the test statistic; continuity correction is only used in the 2-by-2 case if 'correct' is 'TRUE'. Otherwise, if 'simulate.p.value' is 'TRUE', the p-value is computed by Monte Carlo simulation with 'B' replicates. This is done by random sampling from the set of all contingency tables with given marginals, and works only if the marginals are positive. (A C translation of the algorithm of Patefield (1981) is used.)

Value:

A list with class `"htest"` containing the following components:

statistic: the value the chi-squared test statistic.

parameter: the degrees of freedom of the approximate chi-squared distribution of the test statistic, 'NA' if the p-value is computed by Monte Carlo simulation.

p.value: the p-value for the test.

method: a character string indicating the type of test performed, and whether Monte Carlo simulation or continuity correction was used.

data.name: a character string giving the name(s) of the data.

observed: the observed counts.

expected: the expected counts under the null hypothesis.

residuals: the Pearson residuals, $(\text{observed} - \text{expected}) / \sqrt{\text{expected}}$.

References:

Patefield, W. M. (1981) Algorithm AS159. An efficient method of generating $r \times c$ tables with given row and column totals. *_Applied*

Pearson's Chi-squared Test for Count Data Code

```

-----
> chisq.test
function (x, y = NULL, correct = TRUE, p = rep(1/length(x), length(x)),
  simulate.p.value = FALSE, B = 2000)
{
  DNAME <- deparse(substitute(x))
  if (is.data.frame(x))
    x <- as.matrix(x)
  if (is.matrix(x)) {
    if (min(dim(x)) == 1)
      x <- as.vector(x)
  }
  if (!is.matrix(x) && !is.null(y)) {
    if (length(x) != length(y))
      stop("x and y must have the same length")
    DNAME <- c(DNAME, deparse(substitute(y)))
    OK <- complete.cases(x, y)
    x <- factor(x[OK])
    y <- factor(y[OK])
    if ((nlevels(x) < 2) || (nlevels(y) < 2))
      stop("x and y must have at least 2 levels")
    x <- table(x, y)
    names(dimnames(x)) <- DNAME
    DNAME <- paste(DNAME, collapse = " and ")
  }
  if (any(x < 0) || any(is.na(x)))
    stop("all entries of x must be nonnegative and finite")
  if ((n <- sum(x)) == 0)
    stop("at least one entry of x must be positive")
  if (is.matrix(x)) {
    METHOD <- "Pearson's Chi-squared test"
    nr <- nrow(x)
    nc <- ncol(x)
    sr <- rowSums(x)
    sc <- colSums(x)
    E <- outer(sr, sc, "/")/n
    dimnames(E) <- dimnames(x)
    if (simulate.p.value && all(sr > 0) && all(sc > 0)) {
      METHOD <- paste(METHOD, "with simulated p-value\n (based on",
        B, "replicates)")
      tmp <- .C("chisqsim", as.integer(nr), as.integer(nc),
        as.integer(sr), as.integer(sc), as.integer(n),
        as.integer(B), as.double(E), integer(nr * nc),
        double(n + 1), integer(nc), results = double(B),
        PACKAGE = "stats")
      STATISTIC <- sum(sort((x - E)^2/E, decreasing = TRUE))
      PARAMETER <- NA
    }
  }
}

```

```

    PVAL <- (1 + sum(tmp$results >= STATISTIC))/(B +
      1)
  }
  else {
    if (simulate.p.value)
      warning(paste("Cannot compute simulated p-value",
        "with zero marginals"))
    if (correct && nrow(x) == 2 && ncol(x) == 2) {
      YATES <- 0.5
      METHOD <- paste(METHOD, "with Yates' continuity correction")
    }
    else YATES <- 0
    STATISTIC <- sum((abs(x - E) - YATES)^2/E)
    PARAMETER <- (nr - 1) * (nc - 1)
    PVAL <- pchisq(STATISTIC, PARAMETER, lower = FALSE)
  }
}
else {
  if (length(x) == 1)
    stop("x must at least have 2 elements")
  if (length(x) != length(p))
    stop("x and p must have the same number of elements")
  METHOD <- "Chi-squared test for given probabilities"
  E <- n * p
  names(E) <- names(x)
  STATISTIC <- sum((x - E)^2/E)
  PARAMETER <- length(x) - 1
  PVAL <- pchisq(STATISTIC, PARAMETER, lower = FALSE)
}
names(STATISTIC) <- "X-squared"
names(PARAMETER) <- "df"
if (any(E < 5) && is.finite(PARAMETER))
  warning("Chi-squared approximation may be incorrect")
structure(list(statistic = STATISTIC, parameter = PARAMETER,
  p.value = PVAL, method = METHOD, data.name = DNAME, observed = x,
  expected = E, residuals = (x - E)/sqrt(E)), class = "htest")

```