Sabine Homann

Indigenous knowledge of Borana pastoralists in natural resource management: a case study from southern Ethiopia




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Institute for Animal Breeding and Genetics
of the Justus Liebig University Giessen
Department of Livestock Ecology: Prof. Dr. J. Steinbach

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by
Sabine Homann
born in Lüdinghausen, Germany

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GLOSSARY OF BORANA TERMS

Abba gadda	President
Abba guya	Delegate for water use and maintenance on a given day
Abba herrega	Delegate for water management
Abba quaee	Convenor of ad hoc meetings
Aburro	Range scout for the assessment of current range conditions
Adaala	Bare ground indicating degradation
Adadi	Shallow wells at the periphery of the rangelands
Arda	Encampment cluster
Ayuna	Small breeding type of the Boran cattle
Barbardana	Lack of grass indicating over-grazing
Borantiti	Membership to the Borana society
Buusa gonofaa	Wealth redistribution after droughts at clan-level
Dabo	Ad hoc assistance group for pooling labour to cultivate
Dhabsu	Livestock drinking frequency (one day)
Dhawa	Co-operation group for daily herding
Dheedaa	Common seasonal grazing area
Dongora seera	Directive to settle in line
Finna	Range condition score
Foora	Remote rangelands, for temporary use of the mobile herd
Furra	Pasture burned every 3-4 years
Gadda	Traditional governance system
Goosa	Clan
Gona	One of the clan moities
Guba	Pasture burned every year
Gu'essa	Non-lactating cows, satellite herd
Gursumeessa	Pasture burned every 2 year
Gumi Gaayo	Pan-Borana legislative assembly
Hayyu	Mediator
Hawicha	Lactating cows, residential herd
Jaasuma	Co-operation group for daily watering
Jallaba	Clan member, appointed as messenger
Jarsa	Elders
Kalo	Fenced forage banks for weak animals

Kara ebida	Pathway used to stop the fire, fire-break
Kara oba	Pathway to watering places
Konfi	Inherited title of ownership to a traditional well
Kora	Local assembly
Kora ela	Assembly of the users of a well
Lafa	Grazing land
Lafa godann	Land for moving the herds
Lafa gue'ssa	Grazing land for the non-lactating herd
Lafa haawichaa	Grazing land for the lactating herd
Lafa seera bonna	Grazing land to be used in dry-seasons
Lafa sera roba	Grazing land to be used in rainy-seasons
Lafa seera yabiye	Orally reserved dry-season grazing reserve for calves
Lafa tesso	Land for permanent encampments
Limmaalimma	Livestock drinking frequency (two days)
Looni gue'ssa	Cattle herd with non-lactating livestock
Looni hawicha	Cattle herd with milking cows
Luuba	Generation-grade in the *gadda* system
Madda	Area related to a permanent water source
Mara qu'ee	Grass near home, preserved for small calves
Marri	Local meeting
Marri loni	Local meeting about where to move the herds
Mata tixaa	Maximal daily grazing distance for cattle
Merri	Tree branches to prevent livestock entering in pond water
Mura	Decision about herd splitting and herd movements
Nagaya Boorana	Peace, moral order
Naaniga	Trough for watering livestock
Obatu	Labour groups for the use and maintenance of water sources
Olla	Village
Oobruu	Crop-cultivated fields
Quallu	Ritual priest
Qorti	Traditional large breeding type of the Boran cattle
Reera	Neighbourhood
Sabo	One of the clan moities
Sadeen	Livestock drinking frequency (three days)

Sanga	Castrated male livestock
Tula	Traditional deep well complex
Waatiye	Calves younger then 5 months
Warra	One family homestead, residence
Warra guda	Main camps
Warree	Early morning herding during rainy-season
Woreda	Representation of formal government at district-level
Yabiye	Young livestock, between 5 months and 2 years

ABBREVIATIONS

AAME	African Adult Male Equivalent
BLPDP	Borana Lowlands Pastoral Development Programme
CBPP	Contagious Bovine Pleuropneumonia
DM	Dry Matter
ESAP	Ethiopian Society for Animal Production
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross Domestic Product
GTZ	Gesellschaft für Technische Zusammenarbeit
GIS	Geographical Information Systems
GPS	Geographical Positioning Systems
IK	Indigenous Knowledge
IW	Indigenes Wissen
ILRI	International Livestock Research Institute
IPPC	Integrated Pollution Prevention and Control
LSU	Livestock Units
m.a.s.l.	meters above seal level
MEDaC	Ministry of Economic Development and Co-operation
ODPPB	Oromia Disaster Prevention and Preparedness Bureau
PA	Peasant Association
PRA	Participatory Rural Appraisal
SNNPRS	Southern Nations Nationalities and Peoples Regional State
SORDU	Southern Rangelands Development Unit
TLU	Tropical Livestock Unit
UNSO and UNDP	United Nations Sudano-Sahelian Office and United Nations Development programme

1 INTRODUCTION

Livestock plays an important role for the Ethiopian national economy. The country has the highest share of livestock in Africa and is one of the world's centres of domestic animal genetic resources diversity (FAO, 2000; ESAP, 2003). Livestock production currently provides about 15% of the Ethiopian GDP and 30% of its agricultural GDP (MEDaC, 1999). For low-income producers, livestock provides cash, physical products and services as well as socio-economic functions, including liquidity and security, and is therefore an important resource of sustainable livelihoods (Delgado *et al*., 1999; Ayalew *et al.,* 2003; Anderson, 2003).

Pastoral livestock production remains the principal economic activity in the arid and semi-arid rangelands of Ethiopia. Pastoralism provides a living for about 6 Mio Ethiopians, an estimated 10-12% of the country's total human population. Pastoralists keep about 40% of the national cattle, half of the small ruminants and nearly all the dromedaries[1]. Through extensive rangeland management they use about 60% of the total area, mainly peripheral areas where no alternative production exists. Despite a strong subsistence orientation, pastoralists provide about 90% of the legal livestock exports in live animals, and 20% of the draught animals for the highlands (Coppock, 1994; Hogg, 1997; Sandford and Habtu, 2000). In addition to that, a considerable unofficial cross border trade occurs (Teka *et al.,* 1999).

The Borana pastoralists were once known for their high productivity in cattle husbandry. With a focus on milk off-take for subsistence and sale of males to maintain a high proportion of cows in the herd, they achieved a higher profitability in cash and energy than is expected of extensive beef production (Cossins and Upton, 1988). Studies on the productivity of indigenous pastoral systems compared to commercial ranching showed that under similar ecological conditions the Borana pastoralists performed 57% better than the Kenyan ranch productivity, using MJ per ha and year of gross energy edible by humans as an indicator (Cossins (1985) in: Behnke and Abel (1996)). In comparison to Kenyan Massai pastoralists, the Borana herds yielded more milk per cow and year (Borana 219-251 kg, Massai 50-235 kg), and obtained higher cash output per head and year (Borana 20-27 US$, Massai 16-24 US$) (Bekure *et al.* (1991) and de Leeuw (1995) in: Behnke and Abel (1996)).

[1] Sandford and Habtu (2000) estimated in a recent study that about 10.9 Mio cattle, 10.2 Mio sheep, 7.7 Mio goats and 2.5 Mio dromedaries are herded by Ethiopian pastoralists.

Result of the Borana pastoralists' successful breeding and selection strategies is the Ethiopian Boran cattle. Exported for commercial ranching to countries like Kenya, Australia, USA or Mexico, the Improved Ethiopian Boran cattle reached body weights of up to 850 kg (Rege, 1999). Under the current conditions of its native environment in the Borana rangelands, the typical Ethiopian Boran cattle are conserved at the government-owned Did Tuyera breed improvement ranch.

The nature of the Borana natural resources and management system reflects typical characteristics of east African pastoralism. Pastoral production systems have evolved under high-risk conditions in dryland regions. Traditionally, they were remarkably resilient to the climatic variability and to external perturbations like droughts. Herd mobility and common property regimes were used to exploit key resources at a larger scale. Thereby the pastoralists sustained the utilisation of scattered rangeland vegetation throughout the year (Ellis *et al*., 1988; Westoby *et al*., 1989; Scoones, 1993; Behnke, 1994). The households' as well as the communities' ability to co-operate in the utilisation and maintenance of the common pool resources was of great importance for maximised livestock production and successful risk management (Blench and Marriage, 1999; McCarthy, 1999).

The Borana pastoralists have been in a favourable position to develop an exceptionally efficient natural resource management. They were specialised on extensive cattle breeding in a semi-sedentary production system. The limited availability of permanent water at the traditional deep wells was the key variable that determined the rules for the utilisation of pastures. Through flexible natural resource use strategies and stratified herd management they matched the livestock to the available grazing and water resources during times of abundance as well as in scarcity. Institutional arrangements and networking within and between pastoral groups were elaborated to enforce decisions among multiple resource users. Thereby, the Borana pastoralists generated a distinct ecological, technological and organisational indigenous knowledge (IK), which enabled them to preserve the Borana rangelands at highest grazing potential in east Africa (Helland, 1982; Coppock, 1994; Hogg, 1997).

However today, the Borana pastoralists are in a deteriorating situation. During the last 30 years the deeply rooted indigenous natural resource management of the Borana pastoralists has experienced severe forms of external disturbances. The pressure to the Borana pastoral system is recent compared to other African pastoral systems and, therefore, it is particularly suitable to illustrate the effects. Notably the establishment of additional watering ponds in traditional rainy-season pastures, a well-intended but poorly designed pastoral development

intervention, has disturbed the IK-based natural resource management through an imbalance between water and forage resources. The imposition of a formal administration which is alien to the indigenous institutions interfered with the co-ordination of access to grazing and water resources. The most direct deprivation of the natural resource base was the formal alienation of valuable grazing and water resources by the federal regionalisation policy. The official ban on burning and the establishment of private commercial ranches exacerbated the disruption of the Borana traditional pastoral system. The extension services favoured crop cultivation within valuable grazing areas and claimed key resources from the pastoral production.

The rapid growth of the human population of about 2.5-3% put further pressure on the natural resources, and has severely reduced the per capita availability of these resources. Recurrent droughts aggravated the problem by causing loss of livestock and grazing resources as well as unsustainable exploitation of the surviving resources. The combined impact of all these factors is a progressive degradation of rangeland resources, destruction of important social structures and poverty for the majority of the Borana population (Coppock, 1994; Helland, 1997; Kamara, 2001).

The devastating trends aggravate, because despite the growing recognition of the value of IK for sustainable pastoral livelihood development little incorporation in development concepts and formal legislation has been achieved. Opposed and partly emotionalised views on pastoralists' capability in natural resource management hampered a concerted action among the stakeholders involved. Pastoralists were blamed for destroying the environment by accumulating animals and over-exploiting natural resources. Alternatively, pastoralism was seen as a dynamic adaptation to variable and unpredictable environments (Dahl and Hjort, 1976; Dyson-Hudson and Dyson-Hudson, 1980). There is a general consensus, that the results of the enormous research and development efforts vested in the Borana rangelands have remained far below the expectations (Coppock, 1994). The IK-based natural resource management of the Borana pastoralists has lost the potential to contribute to sustainable livelihoods. It seems that pastoralism which was once capable for efficient production can no longer be continued in the traditional way. Also the capacity for extensive range management is limited.

The above observations have created a re-orientation in research priorities, development planning processes, and policy implementation (UNSO and UNDP, 1994; Lane and Morehead, 1995). Priorities include the dynamics of pastoral management systems and the manner in which they evolve in response to environmental risk and external influences (FAO

and ILRI, 1995; Mortimore, 1998; Kirk, 1999; Ngaido, 2002). The establishment of adequate access agreements to rangelands and water is seen as an important precondition to preserve the viability of pastoral production systems. Revitalising the utilisation of pastoralists' IK is considered as fundamental for the sustainable management of dryland eco-systems.

The Borana Lowlands Pastoral Development Programme (BLPDP/GTZ) seeks to follow the new insights, based on an integrated participatory development approach with emphasis on livestock production. The main objective of the BLPDP/GTZ is to develop concepts and technologies appropriate for the promotion of pastoral and agro-pastoral households, in particular those with a low economical status. The project seeks to facilitate participatory approaches in testing, implementation and evaluation of appropriate natural resource management options in the Borana rangelands. It aims at strengthening the co-operation among the stakeholders involved, networking of the relevant institutions and policy advocacy for the Borana pastoralists. The project management has called for a research study on the potentials and constraints of the Borana pastoralists' IK for sustainable rangeland and water development.

The present research study was therefore carried out in collaboration with the BLPDP/GTZ. The main objective of the research was to analyse the Borana pastoralists' IK and thereby to support the BLPDP/GTZ in developing a pastoral-orientated livestock development and extension concept. The expected results were 1. Appropriate research sites are selected and their natural resource potential is determined; 2. Indigenous strategies and institutions for natural resource management are documented; 3. Interactions between technological and socio-economic determinants of the use of natural resources are evaluated; 4. Interactions between land use strategies and the natural resource potential are evaluated; 5. Organisational adaptations to seasonal supply of natural resources and long-term development trends are discussed; and 6. Recommendations for sustainable IK-based natural resource management procedures are formulated. The research operated at the interface of IK-based natural resource management and the ongoing development processes, laying emphasis on applicability and transferability of research results.

The research study investigates the pastoralists' indigenous ecological, technological and organisational knowledge in rangeland and water management under externally induced constraints. However, in the process of promoting IK, it has become an obfuscate expression, encompassing all sorts of local disposition to development. Therefore, a functional definition of pastoralists' IK has been formulated. It refers to the typically opportunistic range

management, comprising herd mobility, variability in stocking densities and herd diversification (Sandford, 1983). The underlying decision-making structures based on common property regimes were further investigated.

The research could not address the many other facets of pastoralists' IK such as soil taxonomy, forestry utilisation, ethno-veterinarian practices, drought mitigation and gender aspects[2]. This might be a shortcoming, but it was assumed that on the long run, the application of most aspects of pastoralists' IK depends on continuing opportunistic range management.

The applicability of IK under ecological and socio-economic constraints is important for pastoral livelihood systems in Africa. The current situation was specified for the Borana region, where most complex natural resource management structures were assumed. The research was designed as an in-depth case study to develop a more complex understanding of the pastoralists' IK. A multi-disciplinary approach was selected, combining socio-economic and ecological disciplines. Two management systems with a different extent of external interference and differences in functionality in the traditional system were compared. It was tested, whether the preconditions for the Borana pastoralists to apply IK have been destroyed by external interference, and whether still existing IK can be helpful to revitalise pastoral orientated rangeland and water management.

[2] Women are formally excluded from range management decisions. However, they often have social, economic and cultural means of contributing to decisions, difficult to detect for outsiders (Abdullahi Shongolo, anthropologist, pers. comm., 2002). This issue was largely beyond the scope of this study.

2 THEORETICAL FRAMEWORK

2.1 CHARACTERISTICS OF PASTORAL NATURAL RESOURCE MANAGEMENT

Complex pastoral management systems have evolved from the pastoralists' successful adaptation under the harsh conditions of arid and semi-arid rangelands[3]. However, the pastoralists' knowledge and strategies in rangeland and water management are disturbed by inadequate development concepts and policies, and this leads to environmental degradation and the erosion of important social structures (Kirk, 1999). The existing pastoral systems including their local adaptations are highly divers, although they share common development trends (Blench, 2001).

The insights gained on pastoral development in the Borana rangelands are considered meaningful for other pastoral systems. To make the transferability of experience and information possible, first pastoral systems and key management strategies are introduced, and the changing development concepts pertaining to it. Then, the integration of pastoralists' IK for more sustainable development concepts is described. The special situation of pastoral development in the Borana rangelands and the consideration of the Borana pastoralists' IK is characterised in the subsequent chapter.

2.1.1 Pastoral management systems and their environment

Pastoral management systems have been developed under high risk conditions in dryland regions. They are determined by natural environments with high variability in rainfall and recurrent extreme climatic conditions, associated with spatial heterogeneity (Galvin *et al*., 2003). Livestock husbandry is the principal economic activity, often controlled by heavy drought-induced mortality (Ellis and Swift, 1988). Livestock productivity depends on extensive grazing on native pastures, with herd movements in search of forage as the basic strategy (Sandford, 1983; Coughenour *et al*., 1985). Pastoral grazing practices are economically the most efficient form of land use, and reach higher total returns per area land surface than sedentary or commercial ranching (Breman and de Wit, 1983; de Ridder and Wagenaar, 1984; Behnke, 1985; Scoones, 1995b). Crop cultivation is not appropriate under

[3]Typical examples are documented by Dahl and Hjort (1976), Dyson-Hudson and Dyson Hudson (1980), and Bekure *et al.* (1991).

high uncertainty of rainfall conditions.

Pastoral systems are defined as a particular form of range-livestock production systems[4], in which more than 50 percent of all household revenue is derived from livestock or livestock products, and a substantial part of the diet from home-produced meat, blood and milk (Swift 1984). Apart form the economic definition of pastoral systems, there are definitions of pastoral production which include the devotion of labour to livestock and communal ownership of natural resources (Sandford, 1983). In the broadest sense is the self-definition of pastoralists' identity by those who consider themselves as members of a pastoral society, regardless whether they are presently living primarily from pastoral products or not (Waters-Bayer *et al.,* 2003).

Pastoral systems are supply driven (Schiere, 1995; Bayer and Zemmelink, 1998). Herders have to adjust the type and level of livestock production to the available range resources. The high risks of production and survival require highly adaptive management approaches (Niamir-Fuller and Turner, 1999). For quick responses to unpredictable natural events range resources and livestock management are closely associated with the predominant social structures (Upton, 1987; Lane and Morehead, 1995). Dynamic responses to the interplay of ecological and societal factors sustain the long term development of pastoral systems (Morton and Meadows, 2000).

Effective pastoral natural resource management is based on a sound knowledge of local user groups of their environment, referred to as pastoralists' IK in chapter 2.2.2. Pastoralists generate their technical and organisational knowledge by moving their herds across fairly large areas (Niamir, 1990; Niamir-Fuller and Turner, 1999; Schareika, 2003). Recent studies support herd mobility as the key strategy to exploit the heterogeneous rangelands and to improve the survival of herds during droughts (Oba *et al*., 2000a; Fernandez-Gimenez and Swift, 2003). It is embedded in local biological, legal-political, socio-cultural, and economic frame conditions.

The primary productivity of African rangeland eco-systems is distinguished by a remarkable resilience to external perturbations like droughts and episodic grazing pressure (Ellis and

[4] Jahnke (1982) defines range-livestock production systems as those which are based on the utilisation of natural vegetation through domestic ruminants. Pastoral systems are one form of range-livestock production, to be differentiated from sedentary ranching systems.

Swift, 1988; Mace, 1991; Dodd, 1994). Bio-mass production and forage quality are preserved in spatially and temporarily heterogeneous landscapes. Pastoralists make use of the natural potential by expanding the usable area of the rangelands through herd movements. The access to a large number of rangeland patches of different productivity reduces the high variability at the micro-level (de Angelis and Waterhouse, 1987; Coughenour *et al*., 1990; Ellis *et al*., 1993; Scoones, 1995a, 1995b). Key-resource areas play a vital role. They are defined as those patches which secure survival of herds in periods of scarcity, and they favour rapid recovery of herds after a drought. Control over key-resources sustains production from more marginal resources at other times of the year (Scoones, 1991, 1993; Illius *et al*., 1998).

Livestock production is adapted to the variable primary productivity. Recurrent droughts are the major constraint, and appear in cyclic sequences as of 1. the initial crash, 2. the bottom of the drought cycle and 3. the beginning of recovery. The relative total outcome of the livestock production within each phase is primarily a result of the local pasture production, and further influenced by the prevailing economic conditions. Drought risk is basically minimised by increasing herd size in rainy-seasons in order to have a large herd at the beginning of a drought and thereby to ensure that at least some parts of the herd survive (Toulmin, 1995). Pastoralists also combine livestock species with different advantages in feed requirements, adjustments to grazing pressure, drought survival and recovery from droughts (Jahnke, 1982; Bayer and Waters-Bayer, 1995).

Local breeds and ecotypes have developed special traits to cope with the high fluctuations in forage supply. They differ by basal metabolic rates, selective forage behaviour and forage intake, water requirements and energy requirements during droughts. Their recovery from drought is enhanced by increasing conception rates and compensatory body weight growth in rainy-seasons, when forage is abundant and the drought period is not too long (King, 1983; Nicholson, 1987). Local breeds are also distinguished by a better resistance or tolerance to infectious diseases and parasites (McCorkle, 1999; Kahi and Rege, 2001). However, epidemic diseases such as rinderpest, anthrax, CBPP or brucellosis are the second factor that leads to catastrophic declines in livestock, and accidentally devastates the pastoral herds. To reduce the risk of loosing livestock, pastoralists move their herds into other areas, and they have developed efficient systems of livestock exchange and loan. They also use elaborated ethno-veterinary techniques, based on indigenous knowledge and locally available resources (Mathias-Mundy and McCorkle, 1989; Mathias *et al*., 1997; Blench, 2001).

Pastoral decision making structures are typically designed for flexible responses to the

temporarily and spatially variable rangeland and water resources (Roe *et al*., 1998). Institutions for pastoral natural resource management are basically collective. The ownership of natural resources and authority over their utilisation is deliberately vested in pastoral groups. The responsibility for the utilisation and the conservation of the natural resources is nested in extended networks. Rules and regulations for the access to shared resources are accommodated by varying degrees of temporary exclusiveness (Behnke and Scoones, 1993; Lane and Morehead, 1995; Swift, 1995). The key-resource concept implies that natural resources are classified into local categories according to criteria of their relative reliability and the value pastoralists contribute to them (Scoones, 1991; Behnke, 1992; 1994; UNSO and UNDP, 1994).

The administration of pastoral range properties is achieved by flexible arrangements rather than formalised prescriptions (Ngaido *et al.,* 2002). Reciprocity agreements, customary laws and informal institutions are valued for immediate applicability and continuous verification through local processes. Risk and conflict management are intrinsic, especially when rights and agreements are overlapping, and the dependency on the limited resources is high (Lane and Morehead, 1995; Swallow and Bromley, 1995; Swift, 1995; Cousins, 1996). Continuous negotiations of conflicting demands are accommodated in the customary institutions, and restore stability and social cohesion. Political networks are important to foster symbiotic relationships to external pastoral groups or to non-pastoral groups such as farmers. The co-ordination of range management strategies and objectives is facilitated by solid links between permanent organisations and ad hoc committees. Detailed units are engaged for small-scale organisation, and larger structures accommodate the regional affairs and therefore involve different administrative responsibilities (Niamir, 1990; Vedeld, 1992; Niamir-Fuller and Turner, 1999).

The social relationships and cultural mechanisms contribute considerably to the flexibility in natural resource management (Sullivan and Homewood, 2003). The cohesion of extended pastoral groups is mainly preserved by kinship, but also by geographic origin. Codes of behaviour, widely held beliefs, and informal and formal regulations are shared by their members (Ostrom, 1990). Emotional attachment and high symbolic value of resources enforce identity and solidarity among the users (Platteau, 1996). The socio-cultural mechanisms built up a reputation for collective behaviour and confidence, and they provide simple and quick decision making for continuous response to a wide range of resources (Ensminger and Rutten, 1991; Swallow and Bromley, 1995; Baland and Platteau, 1996).

Reciprocity is important to sustain relationships within and between pastoral groups. Rights and duties are legitimised by active involvement of the group members in planning and decision making. Enforcement of formal rules and informal codes are assigned to specialists for monitoring and sanctioning or sustained by popular norms and conventions (Sylla, 1995).

The economic benefits from pastoral livestock production are manifold. Pastoral natural resource management makes an important contribution to the sustainable use of arid and semi-arid range lands. By using livestock and livestock products pastoralists fulfil a crucial role for food and livelihood security (Coughenour *et al*., 1985; Rege and Gibson, 2003). Mearns (1996) addresses further values which should be added to the calculations of pastoral livestock productivity: 1) the direct goods and services of pastoral livestock production also include landscape amenity, weeding, draught power, and energy sources; 2) the ecological function-values imply livestock support to enhancing soil fertility, nutrient cycling, carbon sequestration and favoured seed germination (IPPC, 1992; Steinfeld *et al*., 1997); 3) the option-values account for the preservation of wildlife, domestic animal genetic diversity and other forms of conserving bio-diversity (Winrock International, 1992; Koehler-Rollefson and Wanyama, 2003); 4) the existence-value acknowledges the satisfaction that domesticated herbivores are present.

The overall aim in a subsistence-based livestock production is oriented towards increasing the returns of livestock per unit land (Behnke and Scoones, 1993). Especially, the investment of labour - the second endogenous production asset after land - in milk production adds value to the herd output and increases the economic returns per animal (Sikana *et al*., 1993). Therefore, the available labour is pooled between households, and increases the full exploitation of the available range resources. The size of the households is identified as an important variable for the manageable herd size and for herd diversification. Differences in herd size influence the households' labour investments and the physical output of the herds (Helland, 1982; Abdullahi, 1993).

Efficient pastoral livestock production further depends on the household's ability to maximise the use of range resources in average years, and to minimise the risk of high costs in years of low rainfall (Dahl and Hjort, 1976; Dyson-Hudson and Dyson-Hudson, 1980). Pastoralists therefore increase the economic value gained from the direct use of livestock by multiple products and functions. They trade the accumulation of live animals, with milk for own consumption, offspring for reproduction and sale of livestock and livestock products for occurring cash requirements (Jahnke, 1982; Toulmin, 1995). The flexible management

approach enables pastoralists to explore opportunities in forage supply for livestock production, as well as to secure survival through diversification in alternative livestock species or other sources of income (Sandford, 1983).

2.1.2 Key-strategies and management principles

The functioning of pastoral systems depends on the utilisation of 'opportunistic range management'. It is characterised by the employment of key-strategies for the sustainable exploitation of natural resources in a risk-prone environment. These are herd mobility in connection with flexible stocking densities and herd diversification (Sandford, 1983).

Livestock mobility is the best way to exploit the primary productivity varying in quantity and quality, both in time and space (Ash and Stafford Smith, 1996; Fernandez-Gemenz and Swift, 2003). By large-scale mobility pastoralists expand the range of resources. They utilise the seasonal fluctuations in rangeland productivity and the herds gain access to more balanced forage resources. Periods of scarcity are buffered by evading the herds to external rangelands. The patterns of movements correspond to the local rainfalls and the natural resource productivity, towards dryland areas in rainy-seasons and more humid areas in dry-seasons. Irregular movements out of these cycles occur in case of disease outbreaks (Ellis *et al*., 1993; Behnke, 1994; Swallow, 1994; Niamir-Fuller and Turner, 1999). Mobility at the micro-level enables pastoralists to manage grazing more intensively. They exploit the different productivity of local rangeland patches by controlled concentration and frequency of grazing. They vary the grazing pressure by manipulating the time of grazing, the location for grazing, and the grazing selectivity of different livestock species (Westoby *et al*., 1989; Niamir, 1990; Scoones, 1993).

Flexible stocking densities are more appropriate to exploit the resilience[5] of the African rangeland vegetation (Niamir-Fuller, 1999; Desta and Coppock, 2002). They also reflect the pastoralists' objective to accumulate excess livestock during good years so that enough heads of livestock can survive drought periods for re-establishment of herds after the drought. Stocking densities are continuously adjusted, to respond to the fluctuations in forage

[5] Walker *et al*. (2002) explain the two aims of resilience management as (1) to prevent the system from moving to unintended system configurations in the face of external stresses and disturbance; and (2) to nurture and preserve the elements that enable the system to renew and reorganise itself following a massive change.

production. The variability in stocking densities reflects pastoralists' ability to consume local surplus forage in years of abundant rainfall, to abandon the areas when scarcity arises, and to allow pasture to recover from defoliation (Behnke and Scoones, 1993; Scoones, 1995b).

Herd diversification improves the adjustment of livestock specific forage demands to the variations in the natural availability of forage resources. Principally, pastoralists select for ruminant breeds and ecotypes which are specialised on survival and adapted to local forage conditions (Bayer and Waters-Bayer 1995). Physiological tracking[6] by low input animals and reductions in fasting metabolism is an important way to increase the number of animals that can be maintained on the limited forage resources (Scoones, 1995b). Different species are combined for the exploitation of the available vegetation. Grazers and browsers use different strata of the vegetation. Small and large ruminants have different mechanisms for coping with droughts and for recovering from droughts. In addition, keeping different species allows for better matching the available labour and skills to the livestock specific grazing and watering demands. Trade-offs between species are utilised seasonally and in reaction to drought by changing the herd composition (Dahl and Hjort, 1976). Therefore, livestock resources in African rangelands are manifold (Otte and Chilonda, 2002).

Stratifying the herds further enhances efficient grazing by adjusting the demands of different livestock classes to the ecological potential, and exploiting their comparative advantages by their exposure to better feed quality. In separate herding units the milking animals are allocated to areas of higher milk demand, whereas groups of dry animals are herded on the peripheral rangelands. Depending on the natural resource availability, the high demanding milking animals can be dried off, to be shifted to the more sturdy dry animals. Or, mating can be timed, so that lactation periods do not coincide with dry-seasons (Coppock, 1994; Bayer and Waters-Bayer 1995, Fernandez-Gimenez and Swift, 2003).

Complementary to the pastoralists' key strategies are critical management principles, which sustain the adaptation to the natural environment. These are common property regimes, risk management and conflict management.

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[6] Scoones (1995b:9) defines tracking as *"the matching of available feed supply with animal numbers at a particular site"*. He suggests different ways for effective tracking, namely by increasing locally available forage resources, moving the herds to available forage resources, reducing the forage intake by animals with low metabolic rates and de- and restocking according to the drought cycle.

Common property regimes provide the legal framework for flexible natural resource management at comparatively low cost for organisation and enforcement, and they create legitimacy (Ngaido, 2002). Social relations rather than territorial boundaries are the base for binding agreements. Common property regulations empower identified groups of users to maintain access rights and ownership claims to a range of resources (Ostrom 1990; Behnke and Scoones, 1993; Thompson and Wilson 1994). Access to resources is defined by clan-affiliation or residence, and entitles to derive benefits from using the resources. Groups, not individuals, are in the position to enforce exclusive rights against outsiders and to determine the duties for their members to maintain the resources. Group members must be capable to make decisions according to temporary and spatial natural resource potentials, and they must be confident that their claims will be effectively protected (Bromley, 1989, 1991, 1992; Baland and Platteau, 1994; Kirk, 1994; Lane and Morehead, 1995).

In an area with enforceable common property allocation, different ownership groups of variable size and composition derive particular claims to different categories of the resources, being nested within larger structures (Behnke, 1992, 1994; Cousins 1995; Ngaido and Kirk, 2001). Ownership claims can tightly overlap and are continuously rearranged to regulate the intensity of natural resource use. The degree of exclusive control varies with the productivity of the resources in question. Restrictions upon outsiders are often more exclusive, when higher benefits can be derived, or when scarcity arises, and also depend on the technology available (Oakerson (1992) in Kamara, 2001; Lane and Morehead, 1995). Key resources therefore tend to most complex rules and regulations, conceptualised in focal point management (Scoones, 1991; Behnke, 1994).

The complexity of common property regimes is based on an authority system of trusteeship, which ensures user rights for every member of the group as well as for future generations (Lane and Morehead, 1995; Swift, 1995). The sense of property and security of tenure has strong implications, though the value of the commonly claimed resources is variable. Operational rules regulate the utilisation of the resources and sanction misuse. Co-operation is requested to accomplish the rights and duties over resources. Gaining access to resources controlled by others is essential and fosters interdependence between groups (Bruce, 1986; Bromley, 1989, 1991; Ostrom, 1990). Therefore, territorial boundaries as well as socio-cultural networks are not fixed, since they would restrict the flexibility (Scoones, 1995b; Toulmin, 1995; Sullivan and Homewood, 2003).

Risk management is crucial, where scarce and unpredictable natural resources affect directly

income and survival. Pastoralists face a variety of risks, such as drought periods, epidemics and raids, which are increasingly aggravated by market instabilities (Coppock, 1994; Swallow, 1994; Turner and Williams, 2002). Pastoral production strategies therefore, are oriented in the long term objective to reduce risk, putting emphasis on herd growth in years of good rainfall, and on secured survival during periods of stress (Dahl and Hjort, 1976; Dyson-Hudson and Dyson-Hudson, 1980). Households traditionally improve risk mitigation by diversity and flexibility in the production goals and production strategies. The typical herd structure with a high rate of females and milk as primary output reflects the strategic need for reliable herd growth and a year round milk supply for subsistence. Herd accumulation, diversification and mobility are means to achieve maximum dispersal of livestock across the landscape (Behnke and Abel, 1996; Niamir-Fuller and Turner, 1999). Marketing livestock in time and reinvesting in herd recovery after a drought is helpful to buffer the risk (Holtzmann and Kulibaba, 1995). Income diversification in cropping, wage and commerce secures pastoral production, either by supplementing income from livestock, or as a substitute when herds have been devastated (Coppock, 1994; Little *et al*., 2001).

Conflict management is an integral part for range systems with high environmental variability, where access to natural resources is based on membership of competing groups, and strongly associated with power relations (Behnke, 1992; 1994; Lane and Morehead, 1995). Conflict management is process-oriented, responding to ecological, economic and socio-political instabilities about contested resources. It includes prevention of conflicts by common rules and sanctioned behaviour. The prevention, mediation and resolution of conflicts gain importance, where more ownership rights for different categories of resources overlap. Special mechanisms - collective acceptance of rules and sharing agreements, common institutions for negotiations and mediation - are designed to stabilise the relationships between groups. Successful negotiation about the resources shared by multiple users depends on accepted local political authority and their representation (Ensminger and Rutten, 1991; Cousins, 1996; Niamir-Fuller, 1999). Turner (2003) stresses, that the mode of contention reflects the functioning of the local institutions, whether conflicts are carried out through political compromise or violent action. Pastoral land use systems are increasingly under pressure and succumb to tension and aggression, between herders as in the case of the Borana and the Somali, or between herders and farmers in West Africa (Bassi, 1997; Breusers *et al.,* 1998; Moritz *et al.,* 2002). Against this background, violent conflicts and military forces become critical factors to be considered in range management, trade and development (Basset, 2002).

2.1.3 Changing conceptions of pastoral development

The role of pastoral natural resource management has been controversially discussed in the course of development. Historically, pastoralists were blamed for destroying the environment and the pastoral allocation of resources was considered as inefficient. Commonly known is the 'cattle complex', which viewed pastoralists as irrational in their livestock accumulation (Herskovitz, 1926). The 'tragedy of the commons' identified pastoral land management as obstacle to progress assuming that communal grazing resources are not controlled (Hardin, 1968). Herders would seek to intensify the exploitation of resources, because the benefits of increasing production are for the individual, but the costs of degradation are borne by everyone. As each herder follows the individual interest, over-exploitation is inevitable. However, the assumptions were based on political prerogatives, and were not supported by research (Homewood and Rogers, 1987; Turner, 1993; Dodd, 1994).

2.1.3.1 Ecological perspectives

The classical 'range-succession-retrogression model' prompted by Clementsian ecology presumes that drought and grazing pressure have similar effects on plant communities (Clements, 1936). The 'equilibrium model' emphasises biotic feedback between herbivores and rangelands. It is argued that over-grazed or drought-damaged rangeland would recover when stocking densities are restricted. These assumptions have promoted conservative interventions like calculated stocking densities and fenced grazing areas (Niamir-Fuller and Turner, 1999). The new ecological evidences and economic development models promise concepts for more sustainable management of African rangeland and water resources (Behnke and Scoones, 1993; Scoones, 1995b). They also provide significant scientific validation of the pastoralists' IK, as base for ecologically and economically adapted and socially accepted management strategies.

The ecologists' view of the 'New Range Ecology' was the starting point for a critical debate, with implications for management and policy decisions. The 'non-equilibrium model' developed by Ellis and Swift (1988) is more appropriate to describe complex dynamics of African arid and semiarid rangelands[7]. These eco-systems are shown as regulated by abiotic

[7] Rule of thumb is that rainfall variability is inversely correlated with the total rainfall, and hence drier systems are more unstable. The thresholds for systems dominated by non-equilibrium characteristics are estimated at rainfall CV > 30% (Caughley *et al*., 1987; Ellis and Swift, 1988).

controls, and not responsive to grazing pressures. Multiyear droughts limit livestock populations, and prevent plant communities and livestock populations to develop tightly coupled interactions. Single year droughts reduce productivity rates of livestock, but induce mortality only if stocking densities are extremely high. Therefore, the impact of drought largely uncouples density dependant interactions.

The 'state and transition model' developed by Walker and Noy-Meir (1982) and Westoby *et al*. (1989) adds to the non-equilibrium model, that rangelands exist in multiple stable states of vegetation, and that there are transitions between the states. The forces to drive a system from one state into another are given by large changes in weather, intense grazing, fire or combinations of factors. Degradation due to over-grazing is unlikely, since livestock seldom reach the density at which they would have significant impact on the vegetation.

More recent research indicates that dryland eco-system dynamics differ in Sub-Saharan Africa, and involve different patterns of non-equilibrium and equilibrium conditions (Vetter, 2004). Accordingly, more arid areas are dominated by non-equilibrium dynamics (where drought induces density-independent livestock mortality which reduces grazing pressure), while more humid areas display equilibrium dynamics (where livestock populations are regulated by density-dependant factors), and many dryland systems encompass elements of both (Ellis *et al*., 1993; Sullivan and Rohde, 2002). Illius and O'Connor (1999) add the argument that the relative abundance of key resource areas determines to which extend a rangeland system is prone to grazing impact. Key resources would regulate arid and semi-arid grazing areas in a density-dependent manner. Evidence from Zimbabwe showed that due to climate variability and droughts livestock density dependent factors never gained an influence on the rangelands and on livestock productivity (Scoones, 1993). Whereas, it was observed in southern Ethiopia, that the cattle population can reach a density which has a negative impact on the vegetation (Desta and Coppock, 2002). It is concluded that continuous high grazing intensity can lead to vegetation change, replacing perennial vegetation by annual vegetation and thereby increasing the annual fluctuations in forage supply. The result is ultimately a decline in rangeland productivity unless stocking densities are reduced (Fynn and O'Connor, 2000; Desta and Coppock, 2002). Oba *et al*. (2000b) further found, that periodic grazing is essential to maintain rangeland productivity, because the absence of rangeland utilisation can cause encroachment of undesirable plants. Bayer and Waters-Bayer (1995) add to the discussion that areas with higher proportion of digestable woody species are less affected by climatic variability and heavy defoliation and thereby enhance the stability of the grazing

system.

The functioning of east African rangeland eco-systems is being conceptualised by spatial complexity[8]. Therein, flexible movements among rangeland patches of different productivity are seen as essential, to support natural resource use at a large-scale and to preserve the rangelands against over-grazing (Galvin *et al*., 2003; Ash *et al*., 2003). Otherwise, permanent changes in vegetation are induced, as observed at high concentrations of livestock and heavy persistent grazing, particularly near watering points and permanent human settlements, or during rainy-season when soils are sensible to damage (Breman and de Witt, 1983; Hiernaux and Turner, 1996). Reid *et al*. (2003) illustrate that bio-physical factors and social factors which limit the herd's access to the full complexity of rangelands cause fragmentation of the rangelands with far reaching consequences for the pastoralists' livelihood systems.

2.1.3.2 Economic perspectives

The economists' view of the 'New Institutional Economics'[9] support the increasing recognition of flexibility, as a viable productions strategy in rangeland eco-systems. The assumption that disagreements in access to natural resources indicate deficient property rights paved the way for empirical investigations in institutional development in Africa (Kirk, 1999). The 'property rights approach' has shown that common grazing resources are well regulated by the pastoralists and comply well with rational criteria of efficiency (Thompson and Wilson 1994; Lane and Morehead, 1995). Pastoralists employ property rights as socially recognised relationships to make decisions for controlled resource utilisation. Pastoral property holders are defined by membership in a group with respect to valorised sets of resources and against the claims of others. Property in this context incorporates bundles of rights which are owned by different parties, to control access to and goods and services derived from resources with different forms of utility. Social systems are intricate to govern

[8] Underlying is the assumption that in drylands the spatial complexity at large-scale is important for the functioning of the ecosystems. However, human intervention has induced ecosystem fragmentation, resulting in a reduction of scale and thereby constrains interactions among the environment and human management (hhtp://www.nrel.colostate.edu/projects/scale).

[9] Institutions are defined as constraints which humans construct in order to structure economic, political and social interaction. As rules of the game of a society, they consist of formal rules (statute law, common law, regulations), informal constraints (conventions, norms of behaviour and self-imposed codes of conduct) and the enforcement characteristics of both. Institutions provide a framework for individuals and groups for the commitment to common objectives, and take account of problems in organisation, power and control (Coase, 1937; North, 1990; Swift, 1995).

and to enforce the different rights and duties over the resources. Property rights function at the interface of the natural and the social environment. They react upon socio-economic, political and cultural changes as they themselves can induce the change (Bromley, 1991; Ensminger and Rutten, 1991; Swallow, 1997).

In fact, different types of property regimes - 'communal property, private property, state property' - describe different actors who can be accorded different bundles of rights, and determine different use and allocation of natural resources. They can change over time, function separately or overlap each other and are to be differentiated from situations of 'open access,' without control (Bromley, 1989, 1991; Behnke, 1994; Swallow and Bromley, 1995; Baland and Platteau, 1996). Swallow (1994) suggests that in pastoral settings the potential value of range resources influences the nature of the property rights. The value of rangelands rises with increasing rainfall, so that areas with higher rainfall tend to more individualised tenure. Other authors showed, that in areas of low rainfall, common property regimes have comparative advantages over individual tenure, as they facilitate the flexible adaptation to the variable environment (Behnke, 1994; van den Brink *et al*., 1995; McCarthy, 1999). 'Fuzzy' or 'fluid' access rights to natural resources are considered as an important constituent for enhancing flexibility in common property regimes (Niamir, 1990; Goodhue and McCarthy, 1999; Niamir-Fuller, 1999). Under increasing population pressure, technology development and market integration the resources become increasingly scarce. Progressively more exclusive tenure systems with more individual tenure evolve, indicating the communities' loss of control over their natural resources (Ngaido, 2002).

Other relevant approaches investigate critical elements of common property management. The 'transaction cost approach' emphasises the costs and benefits for more control of natural resources, and the implications for shifting from common to more exclusive forms of control (Demsetz, 1967; Lane and Morehead, 1995). The transaction costs of policing are high for dryland environments with natural resources of low productivity and great variability. Common property regimes reduce the physical costs for defining resources, and for registration and protection procedures (Bromley, 1989; Ostrom, 1990; Swift, 1995; Platteau, 1996). The 'assurance problem approach' investigates the aspect of tenure security to be provided for individual right holders (Runge, 1986). Common property regimes are favourable for a subsistence society, where community members have low incomes and heavily depend on the variable natural resources. Common property rights foster co-operation, as they promote voluntary support among members and hedge against

environmental risk. But functioning common property depends on the fact whether local communities can make, monitor and enforce rules in rangeland management (Ngaido, 2002).

Co-operation is acknowledged for playing a coalescing role within the process of common property development (Meinzen-Dick and Knox, 2001). Co-operation allows multiple group members to pool their resources, and provides them with identity, coherence and livelihood security (Swallow and Bromley, 1995; Cousins, 2000). The important role of social norms in sustaining the individuals' co-operation, allowing their flexible decision making and preventing from faults is stressed by Baland and Platteau (1996). Gaspart and Seki (2003) showed that through social esteem considerations in co-operative systems the heterogeneity among group members can be reduced and efficiency eventually enhanced. A recent research project on risk management in the Borana rangelands infers that risk, which is idiosyncratic in distribution, can be managed by the communities themselves as long as a basic physical and institutional infrastructure is in place (Lybbert *et al*., 2002).

The 'interest-group approach' dissects the diverging roles and objectives of different stakeholders in the process of institutional change. The interest-group approach is characterised by attributes of bargaining power, as well as political relations and market development (North, 1992). As outlined in Kamara (2001), emphasis is placed on the potential agents who change the existing property rights in order to capture new benefits. Individual attempts for increasing personal benefits are often to the disadvantage of the community. Interests of certain groups are also consistently marginalised (Thébaud and Batterbury, 2001). Leach *et al.* (1999) therefore conceptualised the 'environmental entitlements' framework, focussing on institutions as mediators of the relationships between different social actors and highly contested natural resource claims.

The formalisation of a collective action[10] sector is proposed as hybrid governance structure. A main argument is to better capture the location and situation specificity in natural resource management (Birner and Wittmer, 2000). Knox McCulloch *et al*. (1998) stress the need to enhance technology development through secured ownership rights over common property resources. The strength of collective action in a modernised natural resource management

[10] Knox and Meinzen-Dick (1999) define collective action by criteria of joint investment in technology, including decision making, implementation of rules, representing the community to outsiders and sharing information.

emerges for building social capital and fostering the empowerment of disadvantaged groups and their networking capacity (Meinzen-Dick *et al*., 1997). Place and Otsuka (2002) add that secure tenure has also an implication for the investment in land. They show that agricultural investment in common land is used to enhance security for individuals while fallowing is more practised on secured holdings.

Based on the recent research on land tenure, Deininger (2003) determines the key components for the development of secure property rights as 1) to specify the duration of rights for particular resources according to their investment incentives 2) to define the boundaries of the resources which are required for better enforcement; 3) to determine the subject of rights according to the local circumstances by individual assignments or group rights; 4) to draw on the properties of local enforcement institutions, combining legality, legitimacy and accountability; 5) to determine the value of resources in question as base for the precision by which the rights are defined and enforced, considering a dynamic development.

2.1.4 Implications for pastoral development

Pastoral natural resource management systems received considerable research and development attention over the past decades. But there is general consensus that the outcome of these efforts remained far below the expectations (Coppock, 1994; Blench 2001). The use of the pastoralists' IK for sustainable rangeland and water management has been ignored. Efforts to enhance the pastoral management efficiency by multiple use patterns and flexible reactions to risk were few. Instead, the existing capacity of the pastoralists was regarded as counterproductive for increasing commercial off-take, limiting herd sizes to carrying capacities and protecting the rangelands against over-grazing, and therefore justified institutional and technical interventions (Lane and Morehead, 1995).

Foreign concepts of land tenure policy - nationalisation, privatisation, land titling - constrain the legal and political mechanisms of the local communities (Ngaido, 2002). They deprive the local users of natural resources from ownership claims[11] and disintegrate the customary institutions without replacement. Instead, the appropriation of rangelands and water by foreign investors or by wealthy herd owners from within the communities is encouraged

[11] The notion of 'vacant' or 'waste' land in the French and British colonial law illustrates the view on rangelands as without ownership, to be converted into utilisation (mise en valeur, valorisation) (Kirk, 1999).

(Fratkin, 1994; Cox *et al*., 1998). Especially, the agricultural encroachment into the most valuable grazing resources accelerates the competition for grazing areas and grabbing of most valuable pastures (Van den Brink *et al*., 1995). The increasing competitions for the available range resources create tensions among users and cause violent conflicts among herder groups as well as between herders and farmers (Hendrickson *et al*., 1998; Turner, 1999; Blench, 2001). The disruption of indigenous property structures creates open access situations, increasing insecurity in land tenure and endorsing over-utilisation of the resources. This is in particular the case where states are unable to provide adequate management (White, 1992; Bruce *et al*., 1995; Kirk, 1999).

One of the prime technical interventions in pastoral natural resource management is the opening of water points, associated with controlled rotational grazing schemes, destocking and settlement incentives. Little account is taken of the pastoralists' opportunistic range management strategies. As a consequence the gains from flexible access to key-resources diminish and rangeland degradation progress. The interventions interfere in pastoralists' structures for co-ordinated decision making and thereby contribute to their marginalisation (Homewood and Rogers, 1987; Niamir-Fuller and Turner, 1999).

The pastoralists' socio-cultural requirements and organisations are not sufficiently considered in the process of institutional and technical development (Sylla, 1995; Sullivan and Homewood, 2003). Efforts to implement community organisations without respecting the traditional decision making weaken the local authorities, and important community structures brake down. The communities' capacities to plan and to co-ordinate different form of land use diminish (Vedelt, 1992). Traditional mechanisms for conflict management with outsiders become more and more ineffective (Niamir-Fuller, 1999; Blench, 2001). Within the communities, an increasing heterogeneity in wealth and diverging interests counteract the backbones of common property regimes (Behnke, 1986; Bruce *et al*., 1995; McCarthy, 1999).

Other factors threaten the viability of subsistence pastoralism. Population growth forces pastoralists to remain on less productive resources, and increases of the degradation of their living base are the consequences. Droughts, famine and unfavourable terms of trade against livestock[12] lead to a decapitalisation of livestock and impoverishment of the majority of the

[12] In pastoral environments, unfavourable terms of trades result as of price and supply variability. During droughts, livestock loose weight, many producers have to sell off weakened livestock and

pastoral population (Swallow, 1994; Turner and Williams, 2002). Poor pastoralists cannot mitigate the increasing vulnerability to droughts, endorsing exclusion from social networks and unsustainable exploitation of natural resources (Fratkin and Roth, 1998; Adano and Witsenburg, 2003). Relief for humanitarian assistance without longer term impact on rangeland productivity bears the risk to aggravate the negative impacts on the environment (Hazell, 1999; Sandford and Habtu, 2000). Technological innovation, new market opportunities and labour migration induce the commoditisation of livestock production. Changing the resource-access options and production strategies this can aggravate the disintegration of the pastoral society (Fratkin, 1997, 1999; Ngaido, 1999).

From the above, it is concluded that misconceptions in pastoral development cause damages to the emergent characteristics of pastoral range management systems. The changing environment results in a reduced applicability of pastoralists' key-strategies and management principles. On the other hand side, the positive insights gained in pastoral management systems create favourable trends for pastoral orientated development. The search for appropriate development interventions leads to the questions, (1) how disturbed the pastoral management systems currently are, (2) how useful pastoral management strategies can be for a repair of the disturbances, and (3) how pastoral management can be revitalised after a repair of the disturbances. In answering these questions, the existence and utilisation of pastoralists' IK plays a fundamental role.

2.2 INDIGENOUS KNOWLEDGE IN PASTORAL NATURAL RESOURCE MANAGEMENT

Appreciation of participatory approaches and sociological aspects in agricultural research and extension science promote IK as a key to sustainable development (Brokensha *et al*., 1980; Richards, 1985; Chambers *et al*., 1989; Warren *et al*.; 1989). Many facets of pastoralist's IK are elaborated by empirical research. Aspects of ethno-veterinary medicine, soil and vegetation taxonomy, water and forestry resources, tenure arrangements, mobility patterns and breeding concepts are described (Mathias-Mundy and McCorcle, 1989; Niamir, 1990; FAO, 2003). Recent studies emphasise the importance of pastoralists' IK in opportunistic range management and risk mitigation mechanisms (Kraetli, 2002). A priority for future

thereby the price goes down. Simultaneously, the demand for grain increases, and the prices of grain opposite to those of livestock goes up.

development investment is seen in the better integration of pastoralists' IK in negotiations with development planners and decision makers (Niamir-Fuller and Turner, 1999).

The integration of pastoralists' IK into sustainable development processes needs a pragmatic framework. In the following therefore, first basic terms and processes of IK-based development are described, and are then transferred to the pastoral situation. Finally, the implications of operationalising IK for pastoral natural resource management are pointed out.

2.2.1 Indigenous knowledge and development

The definition of IK, in its multiple notations and different meanings, is controversially discussed (World Bank, 1999)[13]. According to Richards (1985) IK is characterised by attributes of 'ecological particularism', generated in a local natural environment and under specific ecological relationships. Moreover, IK is a 'cultural heritage', being experienced, tested, and transformed by a given community over time (Brokensha *et al*., 1980). It is utilised as an information base which facilitates communication and decision making in a particular society (Warren and Rajasekaran, 1993). The carriers of IK are indigenous people, who are unique to the given context (Warren, 1991; Warren *et al*., 1995). They share the common burden of having a historical continuity at a locality which became manipulated by dominant outsiders. They are excluded from access to production resources and important management strategies are destroyed (Cannon, 1995). IK-based development concepts and methodologies therefore have to consider technical, cultural and political aspects and their dynamic interactions (Bebbington, 1994; Haverkort *et al.,* 2003).

In comparison, the concept of local knowledge gives more emphasis to a place or a locality, in which the collective experiences are generated and transferred. Local knowledge thus includes IK referring to the particular ecological and socio-cultural context, but it does not necessarily imply a political connotation. Local knowledge and IK differ from traditional knowledge, as they are dynamic in nature rather than static, and continuously integrate new information from external sources (Antweiler, 1995).

A dichotomy characterises the classification of IK and scientific knowledge. Science is conceived as systematic gathering of information about isolated parts of reality, and searches for information of universal significance, referred to as 'immutable mobiles'. IK, in contrast,

[13] Antweiler (1995) and Roeth (2000) compiled an overview on the many definitions related to IK.

is a social product and closely linked or even restricted to an environmental and cultural context, referred to as 'mutable immobiles' (de Walt, 1994). Simplification of this characterisation has lead to historical bias of scientific theoretical knowledge assuming superiority to indigenous practical knowledge. However, similarities between IK and science have been postulated, showing that IK and science operate with context-determined experimental and theoretical knowledge (Agrarwal, 1995). In the current debates on sustainable development, it is argued to make use of the complementary strengths and weaknesses of IK and science (Scoones and Thompson, 1994; Warren *et al*., 1995; Blaikie *et al*., 1997; Langill, 1999).

In the context of sustainable development, IK can be conceived as the result of consultative 'learning cycles' (Long, 1992). Accordingly, IK is a product, which emerges out of social interaction, often in situations of competition and conflicts. IK dissemination is embedded in social relationships and requires ongoing interpretation. IK generation is therefore a social process within dynamic systems, and among multiple actors and networks (Roeling, 1990; Long and Villareal, 1994; Scoones and Thompson, 1994; Flavier *et al.,* 1995). Berkes *et al*. (1995) point out, that skills, expertise and competencies are involved in the utilisation and the transfer of IK. Engel (1995) underlines that knowledge is transferred during learning opportunities, joint by the users of different kinds of knowledge. The so conceived knowledge is tacit, and manifests as technical and organisational know how. It cannot be formalised or transferred, and is difficult to explain (De Walt, 1994; Ray, 1998). In this view, learning is understood as the 'problem solving process' among the involved actors. The actors take purposeful action in response to their experienced environment. Theoretical information and practical experience are incorporated in the attempt to improve their situation (Checkland, 1981, 1985; Ison, 1993). Communication is the process which is brought forward by the actors to create knowledge that will lead to action. Communication thereby shapes the structures for the processing of information (Russell and Ison, 1993). Information, thereof, subsume the facts, processes and relationships, which are generated and transferred through communication, being exposed to mutation (Roeling, 1990).

The generation of IK is emphasised as a 'social construction'[14]. The actors are actively

[14] Pearson and Ison (1997) refer to grassland systems as social constructions, unique to individuals and groups in space and time. People with different experiences have different perspectives and different relationships to the prevailing grassland systems.

engaged in the construction of knowledge, and operate within a certain context which has an influence on how the actors utilise their knowledge (Bebbington, 1994; Fussell, 1996; Blaikie *et al.,* 1997). Ford *et al.* (1993) suggest 'constructive modelling processes', by which actors organise their experiences and validate their utility over time, in order to reconfirm their anticipations or to prescribe changes. North (1990) uses the notion of 'mental models', to describe how people explain their environment and decide how they structure it in the special case of facing uncertainty and complexity. These models draw attention on the fact that IK becomes internalised in culture and practices, and transmitted to next generations it secures the reproduction of the social constructed reality (Gadgil *et al.,* 1993).

The distribution of the above described IK, also referred to as 'culturally shared pool' or the 'socially co-ordinated stock' of knowledge, is closely related to social structures (Scoones and Thompson, 1994; Roeth, 2000). Social groups rely on a common core of IK, based on cultural traditions, individual innovation and acquired information. The common IK becomes gradually transformed into changes in behaviour and decision making (Simpson, 1994a). Within a group, different sub-groups and individuals can dispose on considerably different degrees of specialisation in various fields of IK, triggered by categories of gender, age, education, religion, or status (Roeling, 1994; Antweiler, 1995). The distribution of IK has an impact on the balance of power, because groups and individuals use knowledge potentials to gain advantages in production (Fairhead and Leach, 1994; Berkes, 1999). Vice versa, the distribution of power has an impact on the access to IK (Long and Villareal, 1994). As Simpson (1994b) points out, the distribution of IK depends on the local ranges of experiences, the access to resources, the opportunities for observation and the exchange of information. Unequal distribution of IK needs to be considered by development interventions which aim at strengthening the local management capacities.

IK plays a vital role for rural development. The literature of 'Farmer First' (Chambers *et al*., 1989) and 'Beyond Farmer First' (Scoones and Thompson, 1994) accentuates this knowledge as emerging out of the adaptive rationality of farmers/pastoralists experimentation. Local farmers/pastoralists build up remarkable 'co-ordination skills', through their continuous interaction with the local resources and a multitude of external factors (Richards, 1985; Fussell, 1996). Gadgil *et al.* (1993) underline the value of IK in 'rules of thumb', achieved through observations and trial and error over long times, and preserving complex eco-systems. In 'farming styles', IK synthesises ecological, socio-economic and political qualities by which local actors can make best use of the locally available resources (Van der Ploeg,

1994). Floquet (1993) stresses local innovations as an opportunity, in which local actors have comparative advantages over researchers, as they can better identify the most appropriate possibility of adapting a new technology to the available resources. Other authors have pointed out, that local actors who apply IK being characterised as idiosyncratic can exploit considerable economies of scale (Pollack, 1985; Rosenzweig und Wolpin, 1985). However, the major restriction of IK is that it can only be generated through continuous application. Its disappearance signalises a loss of the communities' capacity for sustainable management of ecological complexity and cultural diversity (de Walt, 1994; Ray, 1998).

Making use of IK in development processes challenges the interaction among actors representing different knowledge systems[15]. As Roeling (1994) postulates, facilitating the integration of different knowledge systems can lead to synergetic effects. IK can add value to the output of formal research and extension. In turn, research and extension messages can enhance the pastoralists' own development capacities. For detailed analysis, Long and Long (1992) suggest the 'interface approach', focussing on the roles of the different actors and the relationships between them. Accordingly, knowledge processes take place at multiple interfaces, when individuals with differing knowledge backgrounds and cultural constructions encounter. At the interface, the actors enter into negotiation processes through which certain information is communicated (Arce and Long, 1992; Long, 1992). Interfaces entail not only a definition of actors, multiple realities and diverse practices, but also involve important aspects of control, authority and power (Long and Villareal, 1994)[16]. Understanding the dynamic interaction between the involved knowledge systems is helpful for the development of effective management systems. Establishing negotiation platforms seems a useful form to facilitate the generation of IK in response to local problems and in face of uncertainty (de Walt, 1994; Matose and Mukamuri, 1994; Blaikie *et al*., 1997).

Adopting a systems perspective provides a conceptual framework for the systematic integration of IK in development processes. 'Systems thinking' is distinguished by

[15] The integration of different knowledge systems also bears a potential for conflicts and misinterpretations: *"While scientists may base assessments of sustainability on narrow notions of 'ecological soundness' and 'productivity', local people have a more holistic way of looking at the effectiveness of a particular technology or practice. Their criteria often include social, economic, and spiritual concerns in addition to ecological ones"* Langill (1999:42).

[16] As Scoones and Thompson (1994:25) formulate*"It is on these "battlefields of knowledge" (Long and Long, 1992), through a dynamic process of contestation and assimilation, that innovation and knowledge creation operate"*.

emphasising the way of how to measure and how to intervene (Schiere, Wageningen University, pers. comm., 2000). The 'Soft Systems Methodology' in particular aims at improvements in areas of social concern by activating the actors in - ideally never ending - learning cycles, accounting for the different perceptions of the actors involved (Checkland, 1985). The actors are engaged in the formulation of problem situations, as a precondition for mutual understanding. Then they enter in iterative negotiations, in search of options for an improved natural resource management (Chambers *et al*., 1989; Ison, 1990, 1993; Ison *et al*., 1997). In this process, the local community is envisaged as creative investigator and analyst, whereas external actors are involved as facilitators, providers of occasions and catalysts of development (Scoones and Thompson, 1994). Conceptual modelling is used to identify key-problems and to structure the debate upon opportunities and constraints (Checkland, 1981; Bawden *et al*., 1984). Hard facts and quantitative modelling are used as complementary components to analyse the dynamics and to specify options for improvements for the given conditions (Pearson and Ison, 1997). *In situ* experimentation and evaluation are used to enhance the efficiency of innovation processes and to develop more appropriate technologies (Perezgrovas, 2001). By so doing, systems methodology acknowledges the ultimate relevance of IK as instrumental for genuine development.

Economic analysis emphasises knowledge as motor for endogenous growth processes. Knowledge (education and know how) is considered as a key factor for enhancing 1) endogenous innovation and 2) learning by doing, subsuming a dynamic interaction between the two (Wagner, 1997)[17]. Knowledge entailed in new products and innovative processes is seen as an important precondition for technical progress. It relies on formal and informal modes of knowledge acquisition (Weckwerth, 1999)[18]. However, critical aspects for endogenous growth are seen in the fact that the transfer of newly created knowledge takes often place under conditions of concurrence and insecurity and it bears transaction costs. The limited transferability of technological knowledge requires innovative adaptation in the local context. Furthermore, there are structural constraints such as 1) strategical decision making

[17] The New Growth Theory investigates technical progress as determinant for development, focussing on the effects of a) spill-over in technology transfer and b) positive external effects through research and development (Wagner, 1997)

[18] Weckwerth (1999) differentiates the innovation process in invention as the appropriation of new knowledge, and information as the transferable knowledge as well as technological knowledge as the tacit knowledge involved.

according to political interests, especially under lack of transparency, information and education, 2) deficient enforcement, co-ordination and distributional mechanisms; 3) unfavourable international trade. Wagner (1998) postulates that research and development should therefore improve the conditions for knowledge acquisition in technology transfer, by investment in education, infrastructures and market structures.

Against this background, the advantages of IK-based development are expected in a better communication and new skills in the interpretation of local potentials and constraints. Integration of IK in experimental programmes and validation of new technology can enhance the adoption rates and the sustainability of development interventions. Thereby, IK-based development can become an important way for the empowerment of local actors towards a better control over their natural resources (Warren and Rajasekaran, 1993; Beranger and Vissac, 1994; Waters-Bayer and Bayer, 1994; Blaikie *et al*., 1997; Grenier, 1998).

2.2.2 Constituents of pastoralists' indigenous knowledge

The pastoralists' IK plays an important role to link ecological variability, flexible production strategies and local institutions for sustainable natural resource management. Traditionally, pastoralists show distinct technical and organisational skills, about how to match specific demands of their herds with the unpredictable natural resource supply (Niamir-Fuller, 1999). It is acknowledged, that investments in pastoral development failed largely due to outsiders' insufficient understanding of pastoral management systems (Jahnke, 1982; Sandford, 1983; Salih, 1992). However, the existing pastoralists' IK, being applied under constrained conditions, incorporates learning how to cope with the changing environment. For an integration of pastoralists' IK in development processes, this requires to elaborate on the constituents of its applicability.

Adapted to Antweiler (1995) and Ray (1998), the pastoralists' IK is the collective experience of local user groups, who derive their livelihoods from extensive livestock keeping. The pastoralists' IK has been developed from direct interaction of the user groups and their herds in a typical natural and social environment. It operates under particular economic and political frame conditions, and it is influenced by certain cultural values. It is the product of pastoralists' adaptability in reaction to the external interference, and is therefore dynamic (Warren, 1991; Mortimore, 1998; Emery 2000). The IK subsumes the information and skills by which pastoralists can derive the highest benefits from the available natural resources (Dahl, 1987; Behnke and Kerven, 1995).

Koehler-Rollefson (1996) subdivides pastoralists' IK-based strategies in components of livestock husbandry and nutrition, production and reproduction, breeding, veterinary medicine and social capital. She suggests that the components are overlapping and often not distinguishable. The application of most aspects of pastoralists' IK depends on the ability to pursue what Sandford (1983:38) has defined as the 'opportunistic approach', "*in which the number of livestock grazing is continuously adjusted according to the current availability of forage*". He acknowledges mobility, in connection with variable stocking densities and herd diversification as particularly valuable strategies to establish flexible short term reactions and viable long term trends (Figure 1).

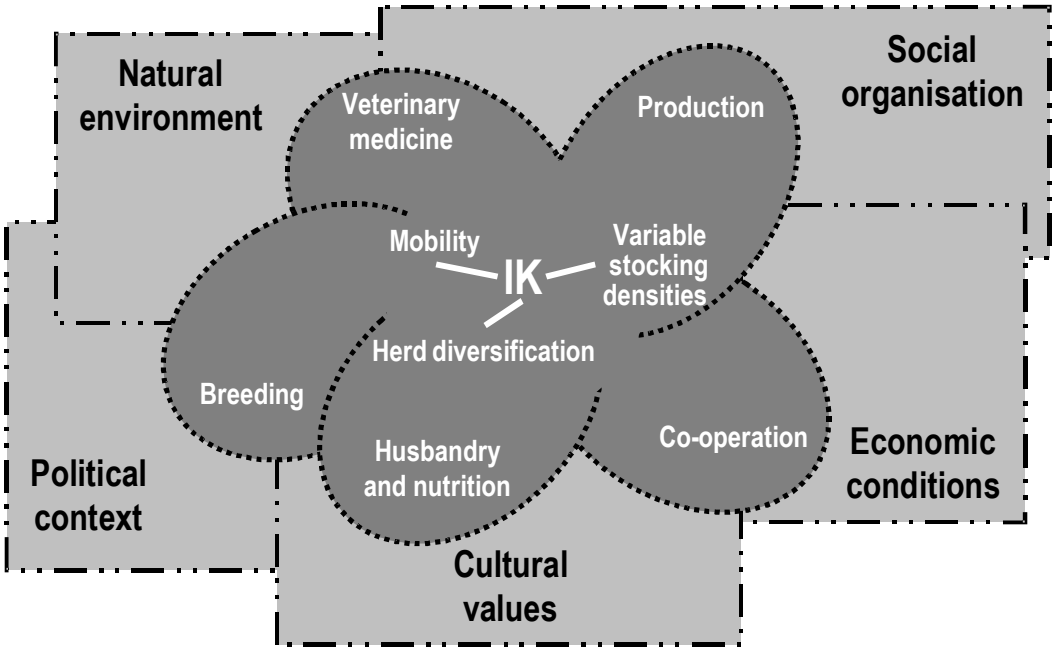


Figure 1. Model of pastoralists' IK in opportunistic range management.
Source: Author after Sandford (1983) and Koehler-Rollefson (1996).

Pastoralists generate their technological IK in range management by repetitive experience and progressive learning, inextricably linked to the seasonal and cyclical quantity and quality of natural resources, and the accessible biological diversity (Stafford Smith and McKeon, 1998; Galvin *et al*., 2001). Climate, soils and geomorphology, plants and vegetation types, water, and animals are named, described, measured and classified according to criteria which are locally considered as important and practical. Intimate observation of ecological processes and detailed interpretation of ecological indicators builds up a solid stock of knowledge. Integrated is the constant monitoring of dynamic changes in space, time and ecological

interrelationships (Niamir, 1990; Oba, 1994).

Pastoralists monitor rangeland and water conditions through observation of long term changes and degradation processes. Indigenous ecological indicators like plant species, their morphology, colour, and density are used for measuring pasture types and quality. They are interwoven with the monitoring on the animals' behaviour and performance, like their modes of grazing, breathing and sleeping, dung colour and composition, body condition, milk production and milk consistency (Niamir, 1990; Hambly and Angura, 1996; Schareika 2001)[19]. Utility values are important criteria and are better discerned by the mobile herders who are in close contact with the herds and their natural environment. Pastoralists' evaluations often entail descriptive information about complex phenomena, and identifying the indicators involved improves the understanding of local management systems (Oba, 1994; Bayer and Waters-Bayer, 2002).

Pastoralists apply their IK through flexible natural resource use strategies, which are elaborated, transmitted and preserved by human interaction. Daily herd movements are the major way to provide information for the manipulation of stocking densities, in combination with different livestock species and livestock categories. At a larger scale, the need of reallocation of herds is crucial for extensive negotiations among user groups and plays an important role for political organisation (Niamir, 1990; Scoones, 1996). Indigenous communication systems are essential to transfer the information and for regular updates of rangeland conditions, water availability and disease risk, as well as temporary user agreements. The effective dissemination of information is realised through agents such as scouts, herders, leaders or traders. The co-ordination of natural resource use strategies with other users ultimately depends on the social networks, developed within and among different user groups. They come into action by various forms of negotiations, and shape the decisions upon temporary arrangements (UNDP and UNSO, 1994; Niamir-Fuller and Turner, 1999).

Pastoralists maintain and conserve IK knowledge in local institutions. Decision making relies on IK and is embedded in complex processes, as a deliberate attempt to provide security to the users and to maintain the chances of survival on the long run (Niamir-Fuller, 1999;

[19] As Schareika (2001) has described, pastoralists build up their knowledge around the interaction between herds and vegetation, and moving the animals is a way of getting to know about how to improve their performance.

Behnke and Scoones, 1993; Roe *et al*., 1998). The divergent interests and conflicts about natural resource use can be seen as a means of redefining the positions and the relations between the groups. The rights and duties for access to the natural resources are continuously to be exercised and defended, depending on the value of the resources, the frequency of their use and the political power of the claimants (Cousins, 1996; Hendrickson *et al*., 1998; Bonnet, 2000). Means of enforcement are sustained by social structure and can be more or less formalised. They can adhere to *ad hoc* agreements, tight regulations, or formalised co-operation among pastoral groups and between different land use systems (Niamir, 1990; Bayer and Waters-Bayer 1995; Lane and Morehead, 1995). Incorporation of IK into culture, ethical standards and religious beliefs is a further help to keep the information in practice for a broad range of users (Gadgil *et al*., 1993; Scoones, 1994).

The IK is unequally distributed within pastoral communities, due to different categories of labour, and stratified by the factors gender, age, status and personal qualifications. As Dahl (1987) describes there are typical tasks related to daily herding, including watering and animal health care, carried out by subordinate herders, like children and workers. Husbandry tasks, including longer term planning and management of the livestock, are decided by the senior herd owners. The housekeeping tasks, including the management and distribution of herd products, and the care of weak and young animals are under the authority of women. Decision making within households is thus characterised by hierarchy, with experienced herders assuming responsibility for range and livestock management. Among households, responsibility is delegated to trustful elders, who join in consultation with other herd owners (Holter and Kirk, 1994; Bassi, 1996).

For the IK in pastoral natural resource management to be used in practice, it strongly depends on the available labour. The management of ecological heterogeneity can only be performed by user groups providing sufficient manpower and skills. Specialisation of labour enables to optimise the multiple tasks related to range management, livestock production and alternative income generation. Labour is pooled among households in order to meet the manifold demands of the herds. Times of labour peaks foster various forms of co-operation with other households and strategic networks with neighbouring groups (Abdullahi, 1990; Sikana and Kerven, 1991). Especially under high risk conditions, shortage in labour becomes a bottleneck for mitigation strategies. Then, the pastoralists' institutional structures gain importance for mediating the existing knowledge and strategies to adapt to the external shocks (Behnke and Scoones, 1993; Thébaud, 1995).

The importance of pastoralists' IK for sustainable natural resource management depends on the 'self-organising' capacity of pastoral systems, based on the institutional adaptability of the pastoralists and the ecological resilience of the vegetation (Abel and Langston, 2002). As a consequence, interventions which de-couple IK from the local resource base are likely to fail, and make the local institutions and the eco-systems more vulnerable (Gadgil *et al*., 1993; Scoones, 1996).

2.2.3 Operationalisation of pastoralists' indigenous knowledge

The modern 'mobility paradigm' for pastoral development focuses on the enhancement of pastoralists' livelihoods. Central to the analysis is the functioning of indigenous natural resource management systems, which enable pastoralists to make use of ecological diversity and dynamic processes (Niamir-Fuller and Turner, 1999).

Experiences gained in participatory appraisals with pastoralists enlighten their IK in local modes of priority setting, measurement and classification. Ranking methods are useful to elucidate the local distribution of wealth and power (Mearns *et al.,* 1992; Swift and Umar, 1994), and to evaluate the local forage resources (Bayer, 1990; Scoones, 1994). Progeny histories attest pastoralists' detailed information about the production and productivity of livestock (Swift, 1981; Armbruster and Bayer, 1992; Kaufmann, 1998). Calendars in combination with quantification show the seasonal importance pastoralists attribute to the accessible vegetation, susceptibility to livestock diseases and peaks in labour demands (Farm Africa and IIED, 1991; Waters-Bayer and Bayer, 1994). Mapping, modelling and diagrams are proven instruments to depict strength and weaknesses of pastoralists' organisations and institutions over time, including pastoralists' perception of development co-operation (Schoonmaker Freudenberger, 1993; Mearns *et al*., 1994). In scenario games and future planning, pastoralists identify critical problems and suggest mechanisms for their solutions (Swift and Umar, 1994; Westphal *et al*., 1994; Homann and Rischkowsky, 2001). Participatory appraisals thereby contribute considerably to a better understanding of pastoral adaptation to constrained frame-conditions.

Contrasting indigenous and western models of natural resource management reveals the comparative advantages of pastoralists' IK in various ways. Turner and Hiernaux (2002) demonstrate that maps of livestock activity based on local herders' knowledge are more effective and accurate for management than those rigorously developed through spatial modelling. Degradation assessment techniques using pastoralists' IK and formal range

ecologists' knowledge show a high correlation in the prediction of trends, but more differentiated valuation of grazing suitability by the pastoralists (Oba and Kotile, 2001). Pastoralists' concerted key-resource management focuses on the control of most valuable resources and maintains marginal range resources indirectly. Control over key resources is valorised for higher efficiency and effectiveness, than dispersed interventions in vast areas (Scoones, 1991; UNSO and UNEP, 1994). Long-time studies on pastoral land use systems proved, that informal social contracts and networks are better in cost recovery and in resilience than formal organisation (Vedelt, 1992, 1994; Swift, 1995; Turner, 1999). Furthermore, systematic comparisons proved that pastoralists' indigenous breeds can provide higher productivity than improved cross-breeds (Blench, 1999; FAO, 2003). It is also recognised, that pastoralists' indigenous livestock marketing behaviour and information exchange channels function differently than western models (Kerven, 1992; Turner and Williams, 2002). Revealing such differences can be a helpful starting point for deeper investigations into pastoral management systems and the role of IK.

Integrating IK in participatory planning approaches[20] has revealed difficulties in the definition of pastoralists' needs, and overcoming communication barriers with outsiders. Waters-Bayer and Bayer (1994) report, that pastoralists' modes of organisation and their interaction with other groups become apparent especially during the implementation of new activities. The planning efforts are more effective when specified to particular activities, rather than subsuming responsibility to a central community body. The competing interests of different groups need to be constantly negotiated. Special caution must be addressed to gender issues, as participatory approaches can provoke the resistance of men and can undermine the informal roles of women. The active involvement of pastoralists in development interventions can show development planners how to improve their approach.

A step further is the integration of IK in participatory monitoring and evaluation[21] of activities implemented with pastoralists. Bayer and Waters-Bayer (2002) point at the priority for platform-building which is based on periodic meetings joined by pastoralists and outsiders.

[20] Pretty and Chambers (1993) highlight the key principles of participatory planning approaches and methods: A defined methodology and systematic learning processes, integration of multiple perspectives, reliance on group inquiry processes, experts as facilitators, inquiry leading to action.

[21] Bayer and Waters-Bayer (2002:5) define participatory monitoring and evaluation as *"... the involvement of multiple stakeholders in the design and implementation of observing, systematising and interpreting processes as a basis for joint decisions about improving their joint activities"*.

The platform is conceived as a continuous learning process, geared by self-evaluation. The objective is to sustain negotiations for agreement of what can be done within the capacities and resources available. Development planners are challenged to facilitate the negotiations and to avoid that foreign concepts impose. Therefore, they require a critical awareness of transparent information transfer, flexible adaptation of methods to questions and clients, and an appropriate follow up. Then, involving pastoralists' IK in joined learning can sustain a process of empowerment, instead of being extracted for manipulation of outsiders' interests.

Development policy and implementation programmes need to incorporate pastoralists' IK (Grell and Kirk, 1999). International donors and agencies such as FAO, UNDP and World Bank have started to consider the role of IK for improved environmental management and work for IK-based development concepts (FAO and World Bank, 2000). In West Africa, the 'Gestion des Terroirs Villageoises' gives an example of the efforts for a legal protection of IK-based natural resource management (Toulmin, 1994). In its initial stage, the approach was criticised for being too much oriented on territory and technical aspects. The interests of mobile land users were largely ignored (Lane and Morehead, 1995; Niamir-Fuller, 1999). Thereupon, the Burkina Sahel Programme investigated in the actor groups involved and their inter-relationships. The objective was to strengthen the indigenous institutions in the negotiation of user rights. As practical tools were selected multi-stakeholder workshops, consultative committees and local evaluation criteria. Banzhaff *et al*. (2000) conclude that a legal ratification of the organs and rules for endogenous development remains outstanding.

Complementary is the commitment for the legal protection of farm animal genetic resources as functional part of pastoral production systems (Geerlings *et al*., 2002). Koehler-Rollefson (2002) addresses the need for *in situ* conservation of farm animal genetic diversity as *"one of the most powerful and valuable assets for future human generations: it represents a genetic "arsenal" for responding to an array of unpredictable events"* (Koehler-Rollefson, 2002:37). The UN Convention on Biological Diversity (CBD, 1992) and FAO and UNEP (1999) acknowledge the need for more active participation of pastoralists in the conservation of farm animal diversity. However, the engagement for the preservation of the indigenous breeds through local user systems remains in a planning stage (Kraetli, 2002). The examples confirm that the existing mechanisms for facilitating a sustainable natural resource management in dryland eco-systems are insufficient. Blench (2001) postulates, that technical inputs will have a limited impact, and that *"Only a major policy re-orientation will protect and support pastoralism during the next millennium"* (Blench, 2001:v).

Operationalising pastoralists' IK starts from taking into account a realistic scenario for its applicability: Pastoralists are increasingly forced into peripheral lands, due to the expansion of human settlements, technical advances in crop cultivation and other forms of land use. The economic conditions are increasingly affected by unfavourable terms of trade, and competing claims are becoming increasingly conflictual. Stochastic events such as droughts, epidemics and market collapse continue to shape management strategies and natural selection processes. It is prognosticated, that pastoralists have to rely on the open rangelands and locally available utilisation practices for the foreseeable future, though the capacity for extensive livestock husbandry is increasingly at risk (Blench and Marriage, 1999; Kahi and Rege, 2001; Kraetli, 2002).

Another significant premise for applied IK is that the variability in pastoral management systems limits the ability to recognise changes in natural conditions in time and to react promptly. As pointed out in the previous sections, pastoral natural resource management involves the entire livelihood system and requires holistic rather than sector specific concepts. The processing of IK can be apprehended by using Scoones' (1998) concept of sustainable livelihoods[22]. Accordingly, IK represents a central capital, which enables the pastoralists to combine a certain set of strategies in order to achieve a certain range of outcomes, based on the given resources. The pastoralists' IK must be kept applicable when to activate purposive adaptations in pastoral range management systems. Re-activating IK in development processes should allow an influence on sustainable livelihood outcomes.

The approach of how to bring pastoralists' IK into a useful form for development processes is necessarily adaptive, and has to be jointly designed by pastoralists and outsiders. Scoones (1996) portrays the procedure as *"ultimately a political process of consensus building between often divergent interests*" (Scoones, 1996:7). The methods and technologies derived, should "*promote interaction among land users, decision makers and professional and technical staff*" (FAO and UNEP, 1999:17). They should sustain a sequential decision making, in which *"...resources are evaluated in the context of objectives, and potential options are identified which can be implemented by the local users*" (FAO and UNEP,

[22] According to the concept, sustainable livelihoods are achieved through access to a set of livelihood resources (natural, economic, human and social capitals), the pursuit of a portfolio of livelihood strategies (intensification or extensification, diversification and migration), and the embedding in a matrix of formal and informal institutions and organisations (Scoones, 1998).

1999:27). The incorporation of pastoralists' IK in development concepts should arrive at the establishment of a pastoral oriented policy framework. Different authors suggest that creating an enabling environment for pastoralists' to apply their IK will foster co-operative relationships among pastoralists and with outsiders. This can help to strengthen viable indigenous institutions, and to re-define the responsibility of the formal institutions (Lane and Morehead, 1995; Sylla, 1995; Roe, 1998).

Based on the above, a basic structure for an IK-based development approach is exemplified in Figure 2. Using the FAO and UNEP's (1999) recommendations of the Integrated Planning for Sustainable Management of Land Resources, this is combined with Checkland's (1989) conception of development as an ongoing learning process. The facilitated IK appears as the result of revitalised management systems, and is re-invested as an instrument for the screening of newly created development options.

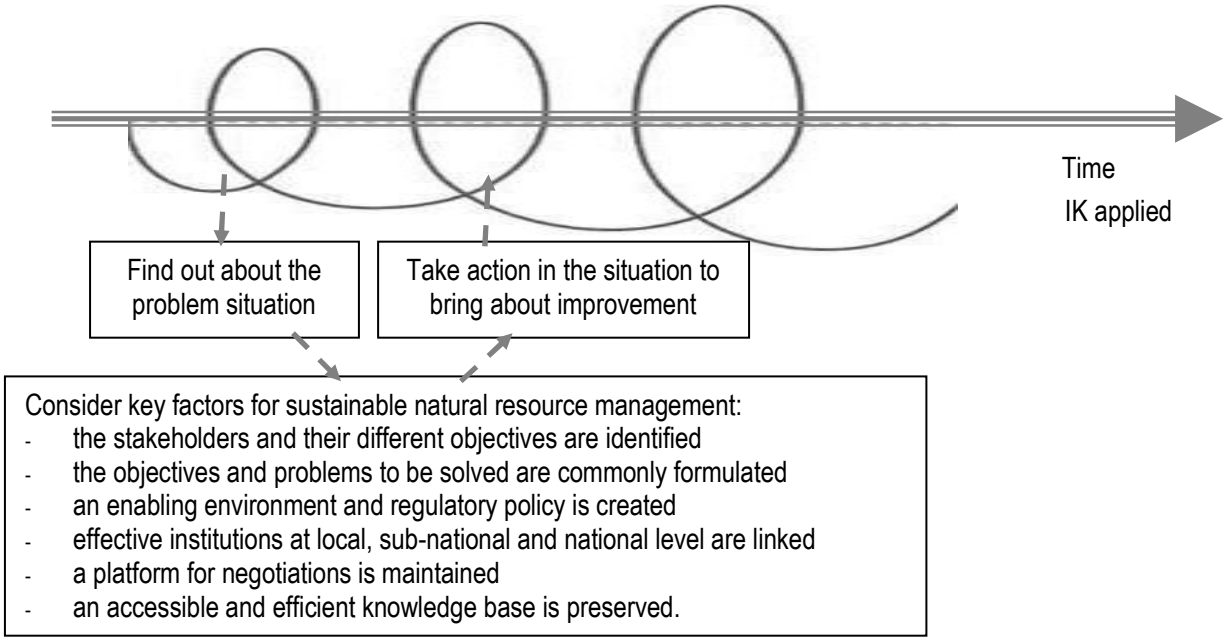


Figure 2. Basic structure of an IK-based development approach.
Source: Author, after Checkland (1989) and FAO and UNEP (1999).

2.3 WORKING HYPOTHESIS

The benefits from extensive livestock production in dryland eco-systems can be manifold. They require a sound functioning of adaptive natural resource management systems. The importance of pastoralists' IK for linking the ecological variability with a flexible natural resource management is now recognised. Pastoralists' IK is applied in herd mobility, and complemented by variable stocking densities and herd diversification. The particular value of pastoralists' IK becomes obvious in situations where drastic changes in living conditions call for permanent adaptive reactions. Development concepts often did not account sufficiently for pastoralists' technical and organisational capacities, the impact of a changing environment and the need to establish relationships with all stakeholders involved. This has resulted in ecological degradation and socio-economic instability, and impinged negatively on the income derived from livestock. Therefore, the use of pastoralists' IK has decreased. But in a situation, where pastoralists are encouraged to apply their IK, they should be able to manage their natural resources more sustainably. The following working hypothesis is put forward:

Today, pastoralists can no longer make full use of their IK-based range management strategies due to inadequate development support.

To test this hypothesis, pastoral systems in the Borana rangelands of southern Ethiopia were selected. The Borana pastoralists were once famous for their efficient organisation and management of natural resources coping with the uncertainty of rainfalls in arid and semi-arid lands. Their good knowledge and proven skills have allowed them to maintain high quality pastures and to breed the highly productive Ethiopian Boran cattle. Since the 1970s, various development interventions have undermined pastoral production, and resulted in a rapid deterioration of the entire system. The pressure is recent compared to other African pastoral systems and, therefore, it is particular suitable to illustrate the effects. It was assumed that the basic constituents of an IK-based range management still prevail.

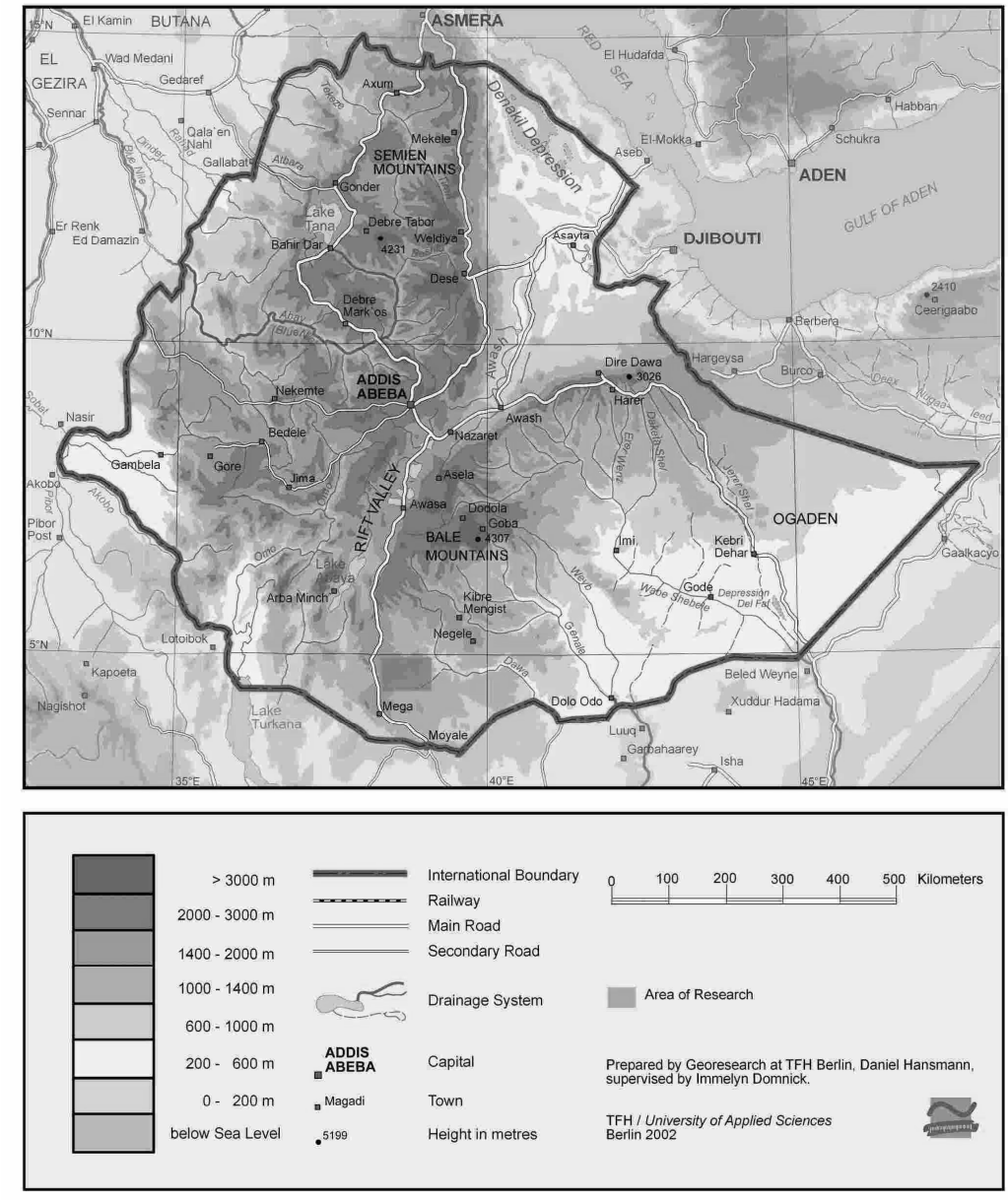
The comparison of scenarios with a difference in development interventions was used to elucidate the effects of changes in the Borana pastoral system. The key strategies herd mobility and variable stocking densities were tested at community-level (first sub-hypothesis in chapter 4).

Based on this, further investigations were made into the socio-economic preconditions for applying IK in a modern natural resource management. Herd mobility and herd diversification were tested at household-level (second sub-hypothesis in chapter 5).

3 STUDY LOCATION AND RESEARCH PROCESS

3.1 LOCATION AND AGRO-ECOLOGICAL CONDITIONS

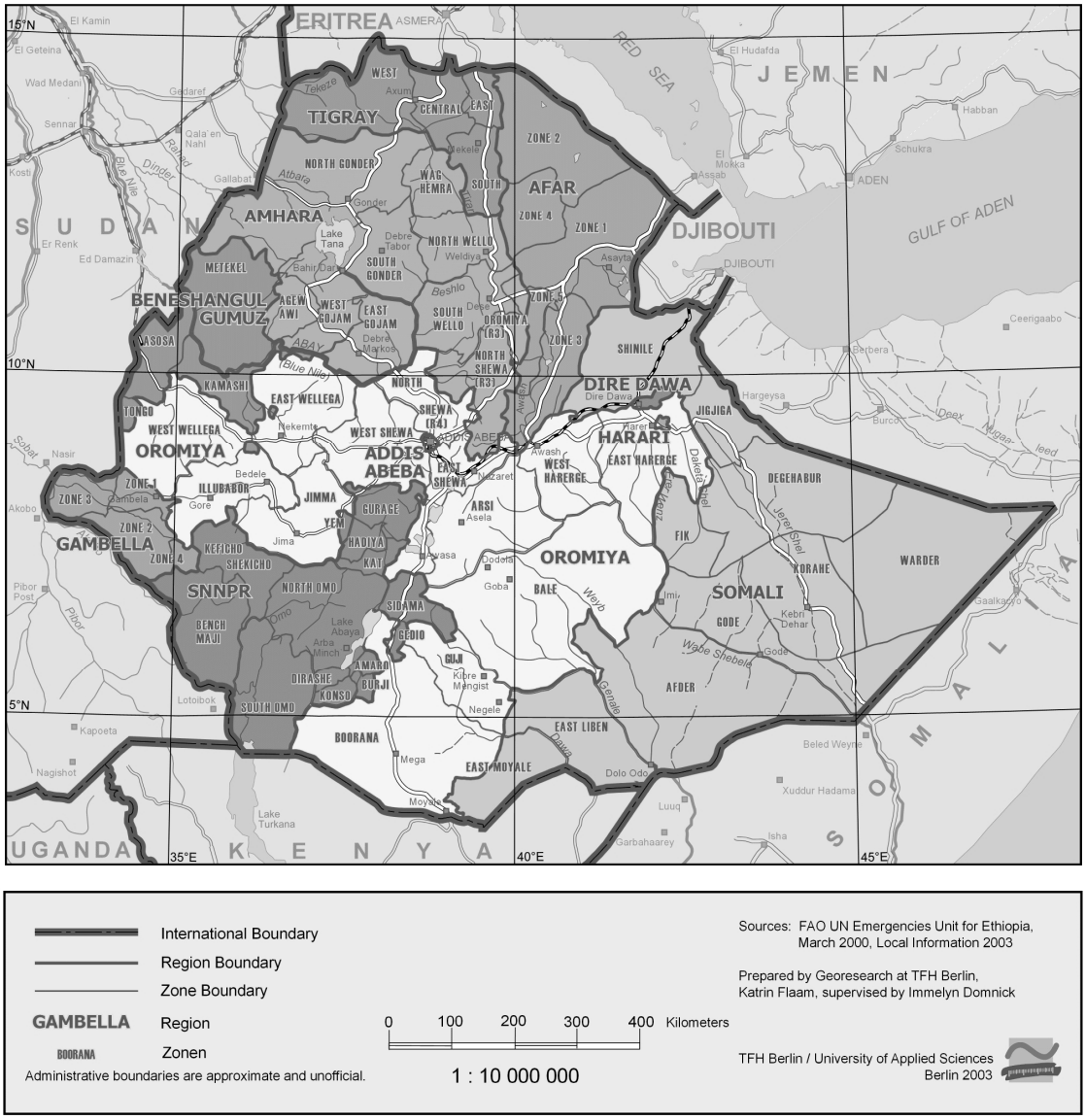
The study has been undertaken in the Borana rangelands in the south of the Federal Democratic Republic of Ethiopia (Map 1; Map 2). The Borana rangelands cover an area of about 50,000 km^2, and are primarily used for semi-sedentary cattle production[23].



Map 1. Location of the research study area in the Borana rangelands of southern Ethiopia.
Source: Hansmann and Domnick, 2002.

[23] The area of the Borana rangelands was calculated from the figures in ODPPB (2000).

The Borana rangelands represent the southern woredas of the Borana zone, and are under administration of the Oromia Regional Government (Map 2)[24]. The area stretches to the national boundaries to Kenya further in the south. It borders the Somali Regional Government in the east, and the Ethiopian highland districts in the north.



Map 2. Administrative boundaries of Borana rangelands in southern Ethiopia (2000/02).
Source: Flaam and Domnick, 2003.

[24] The area has been repeatedly subjected to changes in administrative boundaries by the Ethiopian Federal government. The demarcations outlined in this study refer to the situation during the field research 2000/02.

The Borana rangelands are characterised by an arid and semi-arid climate, with pockets of sub-humid zones. The average annual rainfall varies between 350 mm and 900 mm with a considerable variability of 21 to 68% among years (Kamara, 2001). Rainfall is bimodal, with 60% of the annual rainfall occurring between March and May (main rainy-season) followed by a minor peak between September and November (small rainy-season). The indigenous classification of climatic seasons corresponds to the measurements of monthly rainfall distribution (Figure 3).

Season	Months	Traits
Ganna	March, April, May	Main rainy-season
Adoolessa	June, July, August	Small dry-season
Hagayya	September, October, November	Small rainy-season
Bona hagayya	December, January, February	Severe dry-season

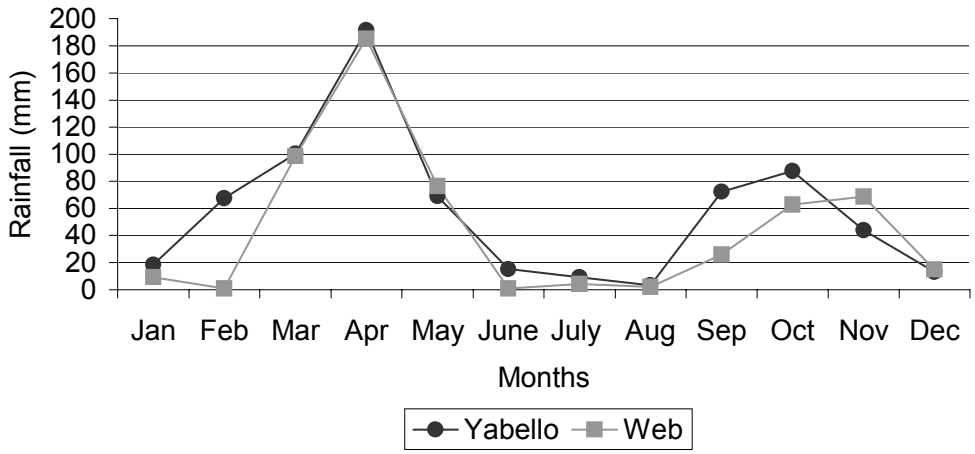


Figure 3. Indigenous classification of climatic seasons in comparison with average monthly rainfalls, at rainfall stations in Yabello and Web (1980-2000)[25].

Source: Available data for Yabello were provided by the National Meteorological Services Agency, Addis Ababa, and for Web by SORDU, Yabello.

[25] Yabello and Web are the nearest rainfall stations to the sample locations.

The long term variability in the quantity and the distribution of the rainfall results in recurrent droughts (Figure 4). In the past, droughts lasting several years occurred approximately once in 20 years and isolated dry years (< 400 mm) once in five years (Coppock, 1994)[26]. Recently, the period between droughts has decreased to 7 years, and the latest drought was observed only 3 years after the previous one. Ndikumana *et al*. (2000) explain that the severe drought in 1995/97 was associated with the El Nino unusually heavy rainfalls 1997/98, and this has increased the livestock vulnerability to death during the 1999/00 drought.

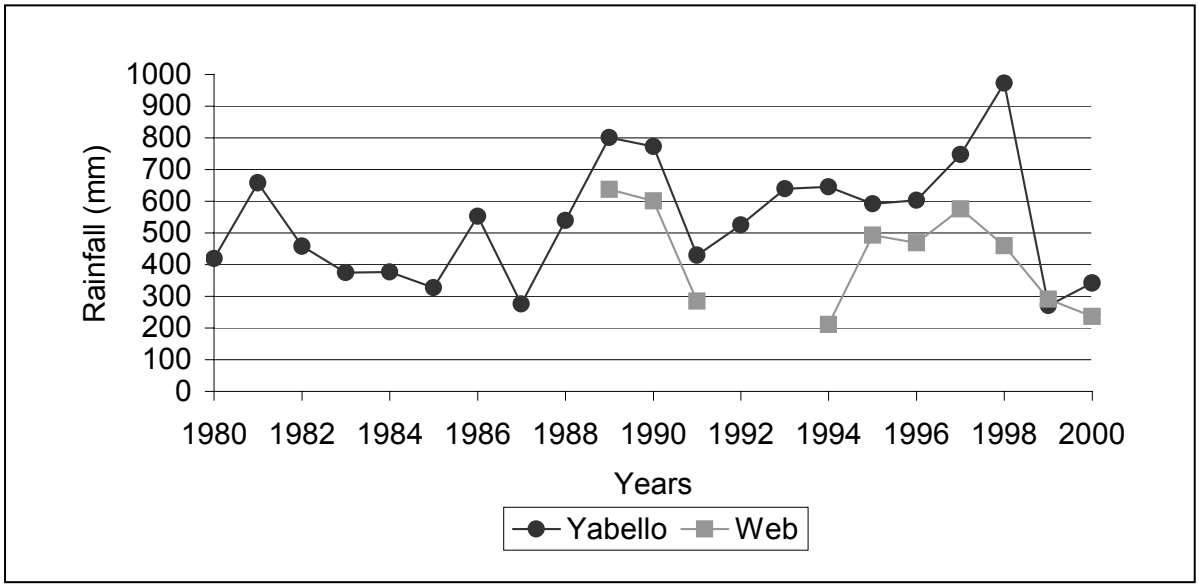


Figure 4. Average annual rainfalls at rainfall stations in Yabello and Web (1980-2000).

Source: Available data for Yabello provided by the National Meteorological Services Agency, Addis Ababa, and for Web by SORDU, Yabello.

The topography in the Borana rangelands is distinguished by plain rangelands, intersected with occasional mountain ranges, volcanic cones and depressions, and an altitude between 750 and 1,700 m.a.s.l. A particular feature is the supply of permanent water by the traditional deep wells. The classical Borana wells (*tula*) are carved out of rock and reach over 30m in depth. The deep wells are located at nine complexes (*tulani sagalaani*), which include up to 30 individual wells, along a central limestone valley (Cossins, 1983; Abgudo Boru, *abba herrega* in Web, pers. comm., 2001). Additionally there are *adadi* wells, a more shallow type of similar design. Together, these wells provide about 84% of the total available water in the

[26] Drought defined by Coppock (1994) is a period when two or more consecutive dry years occur in which the length of the growing period is less than 75% of the mean, and the deficient rainfall has detrimental effects on the production system.

dry-season (BLPDP/GTZ, 1998). The concentration of permanent water sources divides the rangelands into highly exploited zones during dry-seasons around the wells, and peripheral zones which are sparsely grazed during rainy-seasons. In recent years a number of large ponds were constructed in the rainy-season grazing areas. Several salt craters are found in the vicinity to the deep wells. They are the main source for mineral supplements to the livestock (Cossins and Upton, 1987; Coppock, 1994; Oba, 1998).

The Borana rangelands exhibit heterogeneous vegetation. The area is dominated by tropical savannah vegetation, with varying proportions of open grasslands, and perennial herbaceous and woody vegetation (Pratt and Gwynne, 1977). The high patchiness of the vegetation stems from widely varying soils, together with temporally and spatially varying rainfalls as well as the historical differences in land use. Perennial grass is abundant, being particularly valuable for cattle and sheep. Common perennial grass species are *Cenchrus ciliaris, Chloris myscrostachya, Chrysopogon plumulosus, Cynodon dactylon, Panicum maximum, Pennisetum stramineum,* and *Themeda triandra*. Sites with a higher fraction of browse are preferred by goats and dromedaries, being less affected by the climatic changes. Highly nutritive woody species are *Acacia tortilis* and *A. nilotica*. The Borana rangelands therefore offer different vegetation types for grazers and browsers in spatial and in temporal dimensions (Coppock, 1994; Oba *et al*., 2000b; Oba and Kotile, 2001).

Cossins and Upton (1987, 1988) classified the Borana rangelands into four ecological zones of different potential grazing capacity. The area was differentiated in high potential savannah in the northern part, bush land with high shrub cover in the central area, medium potential grassland in the east and volcanic areas in the west. Accordingly, the annual primary productivity varies depending on climate and location between 270 and 150 t DM km^{-2}. For the given rangeland productivity, Cossins and Upton (1987, 1988) calculated potential stocking densities for the whole area, in years with average rainfall of 23.5 TLU km^{-2}, in dry years of 17.6 TLU km^{-2}, and in drought years of 11.8 TLU km^{-2} [27]. The actual stocking density, measured by aerial observation for the year 1982, was in the rainy-season about 14.3

[27] Cossins and Upton had used LSU (1LSU = 230 kg) as standard unit for the calculation of potential stocking densities. They calculated the average adult Boran cattle with 160 kg life-weight as 0.7 LSU, requiring 2 t DM intake $year^{-1}$, giving a total forage requirement of 8 t intake $year^{-1}$. They assumed that an animal needs a daily DM intake of 2.5% of its live-weight, and that the utilisation rate is 25%. For better comparison of stocking densities, the LSU data were converted in the currently used TLU, with 1TLU = 250 kg (Jahnke, 1982).

TLU km^{-2} and in the dry-season about 11.9 TLU km^{-2}, showing that in normal years nearly twice as many animals could be carried, whereas over-stocking would result in drought years when no out-migration is possible[28]. However, for the year 1998 the community survey of Kamara (2001) derived much higher stocking densities, ranging between 45 and 153 TLU km^{-2}, and gave strong evidence that the Borana rangelands are beset by heavy over-stocking[29].

Ecological degradation has become a major threat to the Borana rangelands. Cossins and Upton (1988) estimated that in the beginning 1980s one third of the rangelands were degraded, mainly in the dry-season grazing areas where high stocking densities prevailed over extended periods. Coppock (1994) specified that since the 1980s significant woody species encroachment and the subsequent extinction of preferred plant species has occurred and that in the early 1990s already 40% of the area were affected. Encroachers of low value were identified as *Acacia drepanolobium, Albiza amare, Acacia horrida* and *Acacia mellifera*. An additional 19% of the area was considered as being subject to cropping-induced soil erosion. Further degradation occurs in the forest areas of higher altitude, which besides their ecological value were an additional reserve for dry-season grazing and a source of wood production. Especially the *Juniperus* trees have dwindled at an alarming rate due to over-exploitation (Mengistu, 2002).

3.2 LIVESTOCK PRODUCTION

The Borana pastoralists are traditionally specialised on cattle production[30]. Cossins and Upton (1987, 1988) and Coppock (1994) highlight the high productivity of the Borana cattle system as a result of high stocking densities and a high productivity per animal. The Borana pastoralists maintain a management system of two cattle herds. They split the herds into the stock of milking cows and young cattle kept near the encampments throughout the year (*warra*). The dry herd is grazed at the periphery, where resources are more plentiful (*foora*).

[28] De Leeuw *et al*. (1999) arrive at the permissible stocking density for semi-arid rangelands 20 TLU km^{-2}, based on accessible grazing potentials (Lehouerou and Popov, 1981; Janke, 1982), and feed intake analysis (Winrock, 1992; de Leeuw and Reid, 1995).

[29] Stocking densities, representing the carrying capacity concept, are of limited value for predicting grazing potentials in pastoral areas, but are considered useful for providing average indices to compare grazing potentials, or to approach the general question whether an area is stocked to its full capacity (Turner, 1993).

[30] Cattle play an important role for the Borana society, integrating productive and cultural values, and determining the Borana identity. This study focuses on the natural resource management aspects.

The typical cattle herd structure consists of about 1:4:1:1 bulls:cows:heifers:calves (Assefa, 1990; Desta 1999).

The indigenous breed in the region is the Ethiopian Boran cattle[31]. The Boran cattle are a *Bos indicus breed* and belong to the Large East African Zebu breed group. It is usually white or grey, but also found in red colour, with a characteristic dark hump and pendulous dewlap. The breed is well adapted to the harsh environment and drought stress, and able to walk long distances. The Boran cattle are highly fertile, of good mothering ability, and noted for their docility. They show a high resistance to parasites and diseases. In recent years, crossbreeding with Ethiopian highland cattle has introduced genetic material from the Small East African Zebu type, the Abyssinian Shorthorn Zebu (*Jemjem Zebu, Bale Zebu*). The latter has evolved under conditions of higher rainfall and agriculture. It is smaller, brown and spotted. Information about the crossbreeds is not yet documented (Haile Mariam *et al*., 1998; Reda, 2001).

Livestock production in Borana rangelands is characterised by great variability in forage production (Cossins and Upton, 1987; Coppock, 1994; Desta, 1999). While frequently under-stocked in years of good rains, the gradual herd growth results in high stocking densities, which lead to feed shortage even in years of average rainfalls. The cattle populations suffered losses of 37-42% after the droughts of 1983/84 and 1991/92 (Desta, 1999). Ndikumana *et al.* (2000) found that following the 1995/97 drought the South Ethiopian rangelands experienced the highest crash in the livestock populations at the Horn of Africa, with losses of about 49% of cattle, 52% of small ruminants and 23% of dromedaries. In the latest drought of 1999/00, the losses of livestock in Borana rangelands were estimated up to 82% of cattle, 80% of small ruminants, and 60% of dromedaries (ODPPB, 2000). Kamara (2001) concludes that the drought occurrence is getting more severe.

Livestock populations in the Borana rangelands are dominated by cattle, and small ruminants are secondary (Cossins and Upton, 1987, 1988). Rearing dromedaries has expanded since the 1990s, after the governmental change induced a period of ethnical warfare, followed by heavy droughts. As Futterknecht (1997) reports, Borana herdsmen initially raided dromedaries from the neighbouring Somali and Gabbra tribes and subsequently began to keep them. Kamara

[31] http://www.ansi.okstate.edu/breeds/cattle/BORAN/; http://dad.fao.org/en/home.htm; http://dagris.ilri.cgiar.org/dagris/display.

(2001) estimates the current herd composition in TLU as of 90% cattle, 4% small ruminants and 4% dromedaries. The aggregated herd sizes were found unevenly distributed among the households, showing a strong skewing towards the poorer households with only 2.5 TLU, a maximum herd size of 140 TLU, and an average of 17 TLU per household. The discrepancy in cattle holdings has also been observed by Assefa (1990) showing 14:1 cattle-per-person ratio in better-off households compared to 7:1 in the middle-class households and 2:1 in the poor households. Desta (1999) noted that the ratio of livestock per person has declined within the last 15 years from about 4.1 TLU to 2.25 TLU per person. This indicates a major decline in welfare for many households below the minimum food security (Coppock, 1994).

The human support capacity[32] of the Borana rangelands is by far exceeded. Upton (1986) calculated a human support capacity at 4.8 persons km^{-2}, which is much below the actual population density of an average of 46 persons km^{-2} found by Kamara (2001). De Leeuw and Ray (1995) found similar trends for east African semi-arid rangelands, with 18.5 people km^{-2}, based on 11.7 TLU km^{-2} resulting in 0.6 TLU per person. Jahnke (1982) calculated for the same region 21.1 people km^{-2}, based on 12.1 TLU km^{-2} and resulting in 0.6 TLU per person. The higher human population densities can only be sustained by trading livestock products for grain, or alternative income generation and relief.

3.3 HUMAN POPULATION

The dominant ethnical group in the Borana rangelands are the Borana - the eldest branch of the Oromo people and part of the Cushitic language family - followed by the Somali and the Garri, and a smaller number of Gabbra, Gujji, Burgi and Konso. The Borana have originated from an area at the angle of the Ganale and the Dawa rivers (Map 1; Map 2), and have expanded to the south west of the Dawa river during the second half of the 16th Century. It is commonly believed that the Borana have displaced another Oromo group, the Wardaai, which had originally dug the deep wells. The Borana have formerly maintained close relationships with the Garri and the Gabbra, but were rather hostile with the Somali. The Somali and the

[32] The human support capacity is the maximal human population density that could be supported in a pure subsistence system. Upton (1986) assumes 13.2 TLU km^{-2}, and a livestock productivity of 848 MJ TLU^{-1}, yielding 11,191 MJ km^{-2}. The daily human requirement is estimated 6.4 MJ, arriving at 4.8 persons km^{-2} to be supported in a pure subsistence system. Kessler (1994:273) specifies HSC as *"the maximum level of exploitation of a renewable resource, imposing limits on a specific type of land use that can be sustained without causing irreversible land degradation within a given area"*.

Garri have started to expand their raids into Borana rangelands from the end of the 19th century on and increased their control over large parts of eastern Borana (Schlee and Shongolo, 1995; Oba, 1996; Bassi, 1997).

The social organisation of the Borana pastoralists is determined by genealogy. Two clan moieties form a social division (*sabo* and *gona),* and 17 clans (*goosa*) constitute the descendent groups. The clans are responsible for the management of the deep wells, social security and ritual tasks. They are dispersed over the area, with a balanced representation in the traditional institutions and equal access to the natural resources. Ritual priests (*quallu*) are important clan representatives in spiritual endeavours and are also involved in political-administrative tasks. Other clan authorities are messengers (*jallaba*), organisers of meetings (*abba quaee*), and councillors (*hayyu*) obliged to the welfare of the clan members (Hogg, 1992, Helland, 1996).

The political organisation is under the *gadda* system, with strong social and cultural connotations. The *gadda* system is organised by generation-grades (*luuba*), which alter every eight years in assuming governance responsibility[33]. The *gadda* defines rules, obligations and authorities, and thereby it provides a framework for socio-political stability over long times. The origin of the *gadda* system dates back to the 15th century, and was founded by Gadao Galgaloo (Huqqaa, 1999). The *gadda* system operates through the *Gumi Gaayo* assembly, which is held every eight years in the midway of the ruling generation grade. The *Gumi Gaayo* is the supreme institution for legislation, revision of existing rules and regulations, defence and conflict management, cultural instructions and social encounter[34]. A multitude of development actors - governmental and non-governmental - can actively participate in the assembly. The *abba gadda* is a triumvirate of three selected leaders, with different responsibilities in governance and cultural celebrations (Legesse, 1973; Bassi, 1996; Helland, 1997; Huqqa, 1999).

Geographical units form the spatial organisation of the Borana society. The basic units are

[33] The *gadda* generation-grade system is to be differentiated from the *hariya* age-set system, the latter being an additional system for social organisation and sharing of responsibility. The *hariya* system determines ten blocks of eight years which every man has to pass in his life. Every stage is defined by temporary economic, political and ritual duties, and organises the male part of the society in cohorts with the same age-set identity (Legesse, 1973; Coppock, 1994).

[34] The 38th Gumi Gaayo will be held in 2004. Shongolo (1995) and Huqqaa (1999) give an overview on the settings and the contents of the last *Gumi Gaayo,* in 1988 and 1996 respectively.

stationary encampments with households of 5-7 persons (*warra*), of which temporarily mobile camps (*foora*) are split off. At the stationary encampments, several households join in a circle, and they co-operate in herd management and immediate social assistance (*olla*). Several of such circles are clustered in neighbourhoods with common land use arrangements (*ardaa*). Vast seasonal grazing areas are shared by pastoralists from different origins and pertained with specific regulations (*dheedaa)*. Grazing areas adjacent to permanent water sources are called *madda*, with distinct rules and institutions for their co-ordination (Oba, 1998; Tache, 2000a, 2000b).

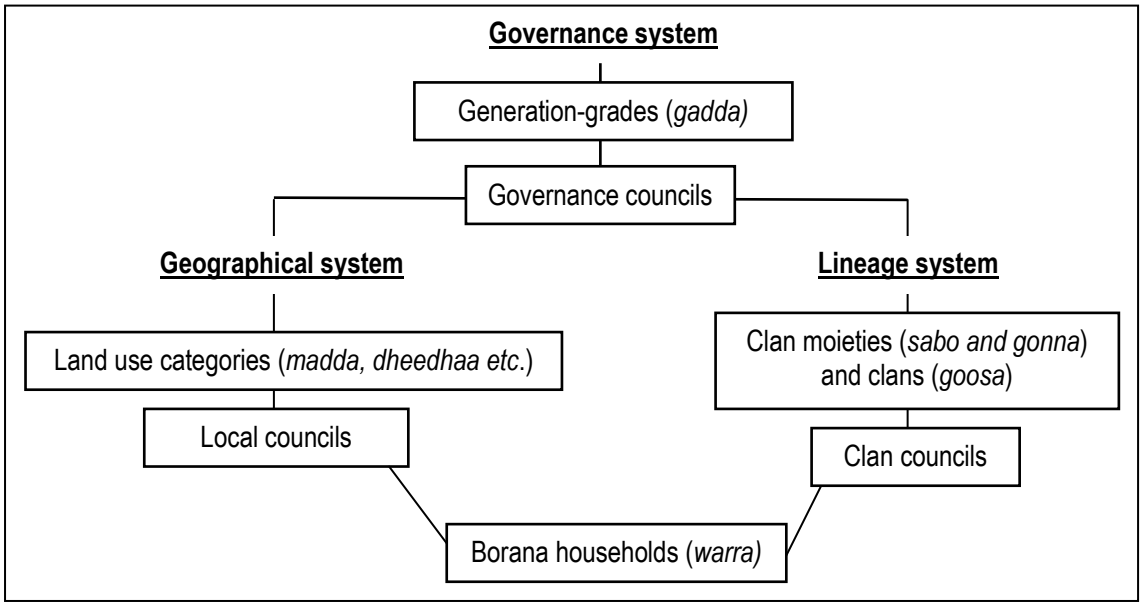


Figure 5. Structure of the indigenous institutions in Borana rangelands.
Source: Compare text, own design, adapted from BLPDP/GTZ (1998) and Kamara (2001).

Further customary mechanisms preserve the functionality of the Borana pastoral system. The peace of the Borana (*nagaya Borana*) incorporates a moral order which has strong devices for co-operation and conflict settlement. The Borana customs and laws (*aada sera*) are laid down in rules of good behaviour, in the many aspects of natural resource use and social life. The quality of being a Borana (*borantitti*) represents awareness for ethnic identity, rooted in the common recognition of laws, customs and rituals (Oba, 1996). As Helland (1982:247) outlines "*Access to these resources is achieved within Borana land primarily by maintaining a Borana identity, by being a Borana, and secondly by subscribing to Borana rules governing the utilisation of pasture and water*".

The total population of the Borana rangelands is estimated at 480,000, with an annual population growth rate that has increased from formerly 1.5% to about 2.5-3% (Coppock, 1994; Helland, 1996, ODPPB, 2000). The population is unevenly distributed, with urban

agglomerations in Negelle, Yabello or Moyale town and few open grazing areas without permanent encampments. An important link to urban markets is the tarmac road from Addis Ababa to Nairobi intersecting the area. Over 90% of the pastoralists' cash income is derived from livestock sales. The unofficial livestock export to Kenya plays an important role with 35-50,000 head of cattle transferred in 1998 (Teka *et al.*, 1999). Further infrastructures are deficient and alternative income opportunities are few (Ndikumana *et al*., 2000; Sandford and Habtu, 2000). Hogg (1997) states, that pastoralists in Ethiopia are most marginalised in access to modern services such as human health and education, reflected by the very high adult illiteracy rate of about 90% (CSA, 1998).

The Borana pastoralists are in a poor situation for income diversification and leaving the pastoral sector, compared to the pastoralists in the neighbouring countries (Sandford and Habtu, 2000). Only few households are able to subsist from their herds. Most households have to exchange on the market expensive livestock products for comparatively cheap grain. The poor households have to take off resources from herd regeneration, and draw on their nucleus herd. Under these unfavourable conditions, the integration into the market economy has further destabilising effects to the Borana pastoral economy (Helland, 1997, 2001; Hogg, 1997).

3.4 NATURAL RESOURCE MANAGEMENT

Traditionally, the Borana pastoralists managed the natural resources very effectively (Cossins and Upton, 1988; Behnke and Abel, 1996). The scarcity of water during dry periods and the spatial distribution of the deep wells require from the pastoralists strong organisational efforts. Co-ordinated labour of large groups of herders is necessary for watering the cattle herds, as well as for the maintenance and rehabilitation of the water sources[35]. Complex arrangements for gaining access to the wells and for their operation are institutionalised at clan-level. The Borana clans have established trusteeship over particular wells (*konfi*), giving clan member's priority for water utilisation. Within a well cluster, the individual wells are under the authority of different clans. The clans appoint managers for the daily operation of

[35] Access to the well water is through long sloping ramps dug into the ground, leading to the deep well shaft. Therein, the water is hauled by a chain of men who pass buckets from one to another and finally into troughs. Cossins (1983) has calculated that a deep well in Borana rangelands had a water production of 80 – 150 l water per minute over a 7-8 h working day. 14-143 TLU could be watered per man-day.

the deep wells (*abba herrega*). The *abba herrega* is responsible for the daily allocation of labour, the user order and an appropriate watering frequency, specified for the different livestock species. The management of water determines the allocation of permanent encampments and the co-ordinated access of herds to the pastures. Water availability has a major influence on the regulation of grazing pressure (Helland 1982, 1997; Oba, 1998).

Mobility was a well arranged strategy by the Borana pastoralists, to make better use of the scattered rangeland resources (Figure 1). The Borana pastoralists used the selective feeding behaviour and tracking potential of different livestock categories to enhance the exploitation of the available grazing capacity. In years of abundant rainfall the cattle herds rotated between dry-season and rainy-season grazing areas. The daily walking distances were between 8 and 12 km. During dry periods and droughts the distances became significantly longer. Restricted watering once every 4-5 days allowed covering greater grazing areas. Herd splitting into lactating stationary groups and non-lactating satellite groups, and sending the satellite groups into remote areas enhanced the exploitation of the grazing potentials. Herd diversification into goats and sheep and increasingly dromedaries further sustained the adaptation to the natural environment and to make a better use of the accessible vegetation. Complex indigenous institutions and common property regimes supported the Borana pastoralists in matching the needs of livestock with the available grazing and water resources. They involved important mechanisms for risk mitigation and conflict solving (Cossins and Upton, 1987, 1988; Coppock, 1994; Helland, 1997; Oba, 1998).

Today, the traditional cattle-based economy of the Borana pastoralists is in transition. The dramatic shrinkage of the available grazing resources has caused an unsustainable exploitation of the remaining rangelands (Helland, 1996, 2001) (Figure 6): As stated before, more than 40% of the rangelands have suffered from degradation within only 30 years. Crop cultivation is expanding, starting from humid areas of higher altitude with more rainfall it encroaches into most valuable grazing areas. Crop cultivation was reinforced by the governmental extension service, and expanded in the 1990s. Today 16% of the total grazing resources are estimated as taken off for crop cultivation. More exclusive forms of land ownership have been induced since the mid-1960s by the establishment of governmental grazing paddocks and private ranches. During the same time the Borana pastoralists started to fence off communal grazing reserves. 13 % of the rangelands are estimated as enclosed (Kamara, 2001).

The growing human population in Borana exerts further pressure on the natural resource base, and has severely reduced the per capita availability of these resources. The result is a decline

of livestock productivity and the impoverishment of the majority of the population, further exacerbating the systems vulnerability to droughts. For the Borana pastoralists the ecological and social instability is still increasing (Coppock, 1994; Desta, 1999; Kamara, 2001).

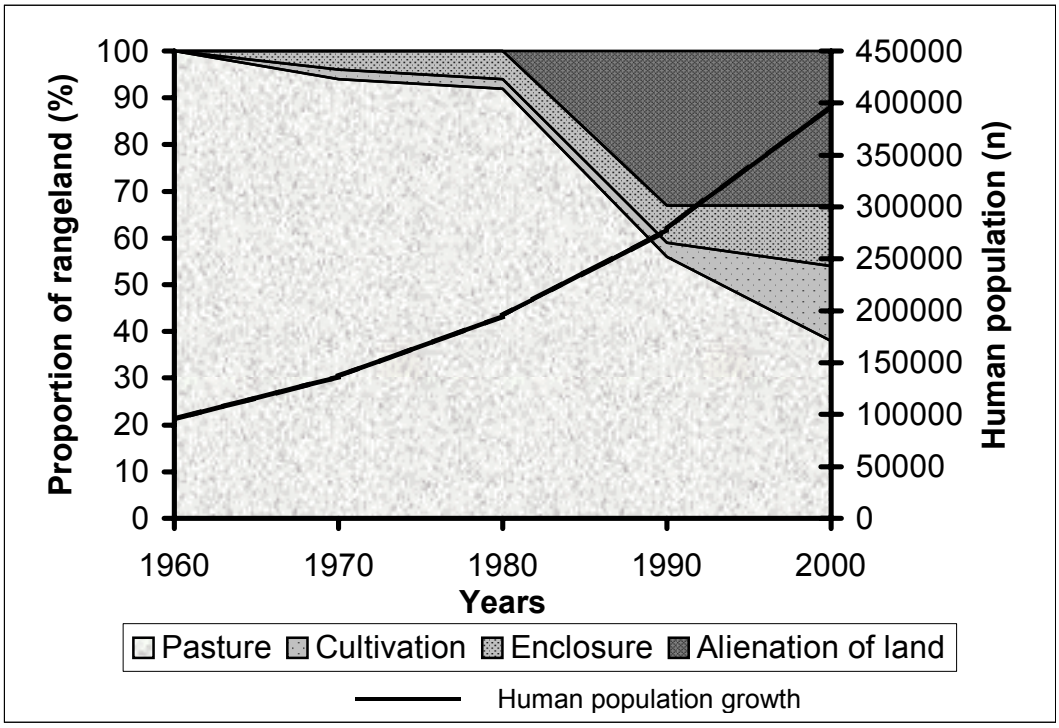


Figure 6. Projection of shrinkage in available grazing resources in Borana rangelands.

Sources: compare text, own design.
Note: The pasture category represents the total remaining grazing land, including degraded areas.

3.5 PASTORAL LAND USE POLICY DEVELOPMENT

In the Ethiopian context pastoral land use policy development is characterised by historical marginalisation and huge political upheavals (Moris, 1999). Under the Monarchy until 1974 the impact of the central government on the peripheral pastoral areas was low. The subsequent socialist *Dergue* regime from 1974 to 1991 was associated with a series of land reform programmes which were imposed by a radical top-down approach. Under the Land Proclamation Act (1975) the land was nationalised. Key institutions were the Peasant Associations (PA), to allocate the land to individual households. The creation of the PAs using the traditional *madda* for a territorially based organisation, blended the indigenous system with a formal structure, but did not recognise the Borana authorities and management systems. Since the change of the government in 1991, the Democratic Republic of Ethiopia tries to reorganise land administration and management. Formally, a decentralisation process has been started to devolve political power to ethnically defined regional administrations such

as the Oromia Regional Government. Rural development planning was delegated to the district-level (*woreda*), to strengthen their linkage with the administration, extension and research programmes at the community-level (Figure 7). Several laws and proclamations have been formulated which can be used for sustainable rangeland management. The constitution implemented in 1995 declares land as a property of the pastoralists[36]. The Land Administration Law[37] is further committed to secure entitlement to rangeland to the pastoralists and to protect their subsistence. As Tache and Irwin (2003) formulate for the Borana context, the Ethiopian national decentralisation of responsibility to the regional-levels and to the local communities is an opportunity to re-interpret policy for natural resource management more in the pastoral context. However, a consistent and comprehensive land use policy is missing and this is seen as a major cause for the continuous process of land alienation. The formal administration remains represented by the PA structure, although it is considered as a political imposition onto the indigenous system, and in fact counteracts pastoral development (Helland, 2001; Kamara *et al*., 2003, 2004).

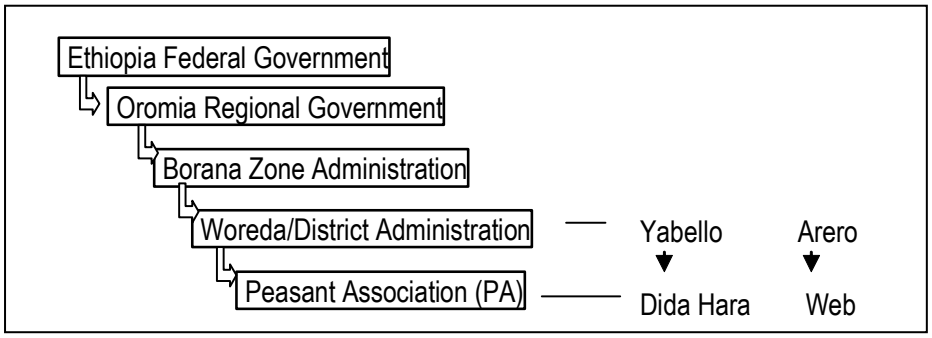


Figure 7. Structure of the formal administration in Ethiopia (2001), with reference to the sites of research.

Sources: compare text, own design.

Keeley and Scoones (2000) describe the reality of Ethiopian policy making as actor networks establishing policy discourses, being embedded in local circumstances and influencing the

[36] *„Land is a common property of the Nations, Nationalities and peoples of Ethiopia and shall not be subject to sale or other means of exchange"*(Article 40.3, , Federal Nagarit Gazeta 89/1997, p 629). *„Ethiopian pastoralists have the right to free land for grazing and crop cultivation as well as the right not to be displaced from their own lands"*(Article 40.5, Federal Nagarit Gazeta 1/1995, p 14).

[37] *„...1.ensure free assignment of having rights both by peasants and nomads as well as secure against eviction and displacement from holdings on any grounds other than total or partial discrimination of holdings effected pursuant to decision by the Regional council; 2. assign holdings sufficient for subsistence both to peasants and nomads subject to the particular condition of the locality..."* (Federal Negarit Gazeta, 89/1997, p. 629-630).

local outcomes for the purposes of those who are in power. Harrison (2003) goes further in uncovering policy development in Ethiopia as a value laden process of contested relationships between the Ethiopian government and the donors and between the donors themselves. Power relationships resulted in vast gaps between policy making and implementation. Lister (2004:8) demarcates policy implementation in Ethiopia by a "*two track structure at all administrative levels. While there is a formal structure of democratic institutions, below the surface there is a party structure that keeps tight control at all levels and ensures that these democratic institutions cannot be used effectively to challenge its power*." The experience with interventions through the Ethiopian government and the current lack of transparency explain the policy deficiency for pastoral development in the Borana rangelands.

In Ethiopia, actors and their position play an important role for pastoral oriented policy development (Lister, 2004):

1. The federal government has reserved its responsibility for policy formulation. Pastoral issues are under the mandate of sectoral ministries. Since 1997 new institutions have been created at federal-level with the potential to promote pastoral interests. The Pastoral Unit at the Ministry of Federal Affairs was established as an inter-ministerial board to co-ordinate pastoral interests between different ministries. The Parliamentary Steering Committee on pastoralists' affairs (PSC) was introduced to assure pastoral representation. However, the new pastoral institutions are under the supremacy of the government in power and can exert only little influence on policy formulation.
2. The role of the regional and sub-regional governments in mediating pastoral interests is limited to policy implementation. The decentralisation has transferred administration to the regional and sub-regional-levels, but not devolved responsibility for policy formulation. The Oromia region has established a Pastoralists Development Commission (OPDC), a multi-sectoral institution for improved implementation activities. Therein, the initiative for participatory pastoral development is announced, but not yet elaborated.
3. The representation of pastoralists in interaction with the Ethiopian government is characterised by cultural diversity and heterogeneous interests. Although pastoral oriented policy making has received considerable attention in the last years, the official structures for linking pastoral interests to policy results are not effective.

The Ethiopian land use policy framework plays a key role for addressing sustainable rangeland use and management. Major policy issues for Borana pastoralists to be resolved are food insecurity, environmental degradation and lack of income diversification (Hogg, 1997).

3.6 EXTERNAL INTERVENTIONS

The natural resource management of the Borana communities has been severely interfered by unsatisfactory experience with technical interventions[38]. The creation of the PA*s* during the dergue regime in the 1970s was the starting point for severe interventions into the Borana range management system. The implementation of the formal administration at PA-level was linked with the establishment of producer co-operatives (PC) and service co-operatives (SC) for providing basic economic services, and included compulsory livestock sales at centrally dictated prices and high taxes. Resettlement programmes for rehabilitation of destitute families, extension service supporting crop cultivation through the supply of agricultural packages at low prices, government sponsored investments in ranches and fattening schemes[39] promoted the sedentary utilisation of land and were a misappropriation of the communal grazing land (Oba, 1998). An official ban on fire was decreed, and this further disrupted the Borana indigenous range management (Hogg, 1990; Bruce *et al*., 1994).

Under the current federal government of Ethiopia the implementation of the regionalisation policy has created political conflicts over resources. The government has transferred an area of about one third of the Borana rangelands and two important wells to the Somali Administrative Region. The ensuing socio-economic and political instability led to inter-ethnical warfare between the Borana and the Somali communities, and made the border areas temporarily inaccessible (Bassi, 1997; Gebre Mariam and Kassa, 2001). Sedentarisation of pastoralists, privatisation of rangelands and conversion to crop cultivation are still on the agenda (Haldermann (2004) in Leonard, 2004). Kamara *et al*. (2003, 2004) have shown that misleading resource use policies have affected indigenous property rights and caused undesirable land use change, including privatised grazing in the name of crop cultivation. As Bruce *et al.* (1994) formulate, the traditional authorities are no longer in a position to control

[38] Kissling-Näf and Bisang (2000:5) underline policy development process as including *„all formal legal regulations, informal co-ordination clauses and institutional structures of a public (protection or use) policy which policy makers (parliaments, governments) and social actors (competing user groups) deem necessary to regulate the use of a natural resource, which is politically perceived as being scarce. A policy design always includes substantial and procedural, material and symbolic dimensions."*

[39] The Ethiopian government founded three fattening ranches for cattle (12,000, 17,000 and 25,000 ha) in the Borana rangelands, to be sold to private investors or to be handed back to the local communities (Coppock, 1994).

the resources and to claim for compensation[40].

The Ethiopian government has started large development interventions in the early 1960s[41]. The main objective was to integrate the pastoral production system into the national economy, by introducing infrastructure development such as the construction of water ponds, ranches and road networks, veterinarian services and marketing facilities. This was based on the rationale to increase productivity by restructuring the indigenous rangeland and water management. Livestock and meat boards were established to increase the off-take for commercial markets. Water ponds were constructed in the former rainy-season grazing areas, to reduce the high grazing pressure in the dry-season grazing areas. They were linked with paddocks for rotational grazing and controlled stocking densities. Additional ranches and a stock route system to the highland areas were established for fattening cattle in the Borana rangelands and to provide male draught cattle for the Ethiopian highlands. Well intended, but inadequate for the pastoral environment and not suitable to solve inter-ethnical conflicts, the projects did not achieve the objectives.

Non-Governmental and bilateral organisations entered during the heavy droughts in 1973/74. Initially they were thought to provide emergency relief and food for work only. However, they gained considerable influence and re-defined their objectives for rehabilitation and participatory development. Research institutions started investigating the Borana rangelands in the 1970s. ILCA started an 11 years co-operative research and training programme, the results have been published in Coppock (1994). Despite the investigations, the Borana rangelands remain in a deteriorating situation, indicated by increasing woody species encroachment and declining livestock productivity. Famine relief has become a contested but

[40] Another related inconsistency is, that although the national economic development policy focuses on Agricultural-Development-Led-Industrialisation (ADLI), investments in livestock production in the Borana rangelands and across borders are insignificant (Teka *et al.,* 1999). According to UNDP (1997) ADLI is largely unimplemented except the crop sector.

[41] Desta (1999) gives an overview on the objectives of the different Ethiopian livestock development projects, with pilot projects in the Borana rangelands: the First Livestock Development Project (1964-75) to increase animal off-take for commercial purposes, and therefore created paddocks and watering facilities; the Second Livestock Development Project (1973-81) to improve the integrated marketing and a stock route system; the Third Livestock Development Project (1975-81) to enhance long-term rangeland rehabilitation and development by restructuring the traditional extensive livestock production; the Fourth Livestock Development Project started in 1988, was implemented in Borana rangelands by the Southern Rangeland Development Unit (SORDU), aimed at utilising the Borana IK and participatory approaches, and it currently operates at a very low capacity.

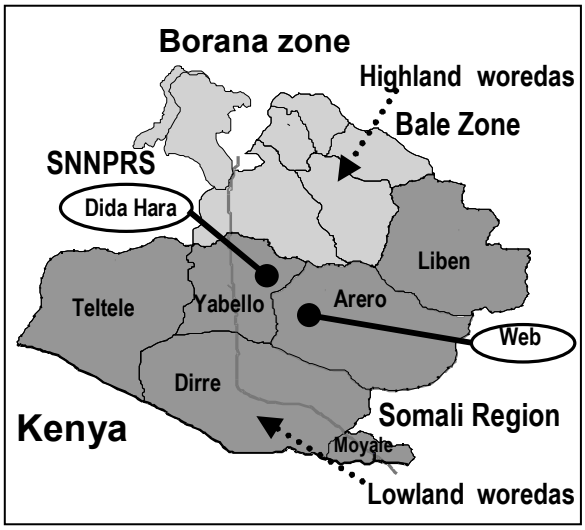
permanent component of the household's income (Coppock, 1994; Desta, 1999).

3.7 TARGET GROUPS

The present case study seeks to explore the level and applicability of the Borana pastoralists' IK in rangeland and water management under the current deteriorating conditions. To identify useful target groups, the data of Abdul B. Kamara's (2001) PhD project on changing property rights, risk and livestock development in the Borana rangelands were consulted. Kamara has done his field research in 1997/98, using cross-sectional community-level data in 17 pastoral encampment areas (PAs). Out of his sample the two PAs, Dida Hara and Web, were selected for the in-depth research (Map 3). They satisfy the following criteria:

- Typical pastoral conditions with low annual rainfall (< 600 mm) and a high coefficient of variation in rainfall between years (> 30%)
- Difference in functionality within the traditional livestock production system (dry-season and rainy-season grazing area)
- Difference in the extent of external interference (low and high interference).

Dida Hara *PA* in Yabello district, with a mean annual rainfall of 539 mm (CV 35%) was selected to represent the location with high interference from outside. Located in the former rainy-season grazing area, *Gomoole*, it is with only seasonally available surface water. The introduction of dry-season watering ponds in the 1970s opened up this area for permanent grazing and uncontrolled encampment, which resulted in rapid deterioration of the rangelands. In contrast, Web *PA* in Arero district with mean annual rainfall of 412 mm (CV 38%) represented the location with comparatively low interference. It is a traditional dry-season grazing area with one of the oldest deep well complexes and a permanent supply of good quality water. Valuable rainy-season pastures for cattle production, *Wayama*, are found nearby.



Map 3. Dida Hara and Web in the Borana rangelands in southern Ethiopia.
Source: provided by LUPO/GTZ.

The selection of sample communities for the in-depth research followed the indigenous

structure of the encampments: Within the encampment areas of Dida Hara and Web three encampment clusters (*ardaa*) have been selected which are located at short, medium and long distance from the centre. The camps (*olla*) were selected from within the *ardaa* on the basis of accessibility. The selection of head of household (*abba warra*) required a preceding assessment of basic demographic characteristics of the communities.

As there was no control situation in a classical sense, the general hypothesis - that Borana pastoralists can no longer make full use of their IK-based range management strategies due to inadequate development support - could not be tested by straight-forward statistical means. First, a comparison of the two locations in relative terms was used to approach the pastoralists' real situation. Consulting a historical perspective shall allow to approach the pastoralists' situation of today, after the disturbance, compared to the situation 30 years ago, before the disturbance. The scenarios of Dida Hara and Web with a difference in external interference were contrasted to elucidate similarities and differences in changing land use patterns and to relate them with IK-based range management. In a second step, statistical analysis was applied to investigate the current application of IK in selected households in Dida Hara and Web. The impact of drought was addressed by comparing aspects before, during and after the last drought in 1999/00. In conclusion, this should allow drawing development pathways for a modernised[42] range management, which are targeted at local pastoral communities and interlocked with pastoralists' IK.

3.8 METHODOLOGICAL CONCEPT

The research study was implemented in co-operation with the Borana Lowland Pastoral Development Programme (BLPDP/GTZ)[43]. Incorporated into a development project, the study was expected to provide practical recommendations, to support the ongoing planning processes of pastoral livestock development and extension concepts, and to be transferable to other pastoral situations.

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[42] In agreement with Tache and Irwin (2003) the term 'modernised' range management stands for the revitalisation of indigenous range management to cope with the changed conditions, and includes new forms of strategies and institutional co-operation. It should not be confused with 'westernisation'.

[43] The BLPDP/GTZ is an Integrated Regional Rural Development Programme and started in 1997 in co-operation between the Ethiopian and the German government. It aims to develop concepts and technologies appropriate to strengthen the self-help capacity of pastoral households, in particular those with a low economical status. (http://www.gm-uncd.org/FIELD/Projects/Organisation/GTZ/Ethiopia/Borana.htm).

Farming systems research methods were used to understand determinants, potentials and constraints of pastoral range management. They integrate the complex interrelationships between the ecological, economic and social environments. The dynamics of the systems and the reactions to influences external to the systems are essential to the analysis (Conway, 1985; Spedding, 1988). Local animal husbandry systems are considered as decision making units and the pastoralists are actively involved in the process of research. Research priorities respond to the pastoralists' problems and their felt needs (Fresco and Westphal, 1988; Chambers *et al*., 1989). The documentation of the pastoralists' current IK was integrated with scientific analysis on processes and interactions, to develop workable, economically feasible and socially acceptable recommendations for sustainable range management.

The present case study was structured as an iterative problem-solving process, by (1) asking the pastoralists' to define main problems in rangeland and water management, thereby accounting for their local perception and experience; (2) involving socio-economic and range-ecology disciplines for an analysis of current pastoral conditions; (3) evaluating applied range management strategies by integrating participatory appraisals and quantitative assessments; and (4) searching for options for improved rangeland and water management and discussing them with the target groups at multi-stakeholder workshops.

Figure 8 gives an overview over the structure and the methods applied in the study. The detailed description of the methods is given with the hypotheses in chapter 4 and 5. The information flow starts from community baseline assessments about the pastoralists' socio-economic situation and range management practices today in comparison to 30 years ago, in order to uncover the current organisation of natural resource management. Key issues were investigated by follow up assessments to illustrate the effects of disturbed IK. Then, the household in-depth assessment was launched to characterise the socio-economic preconditions for currently applied IK. The study on range ecology provided complementary information on pastoralists' IK and current rangeland conditions. At the end of the field research the socio-economic and the range ecology findings were presented and discussed at multi-stakeholder workshops for cross-check of information and for direct feed back to the communities.

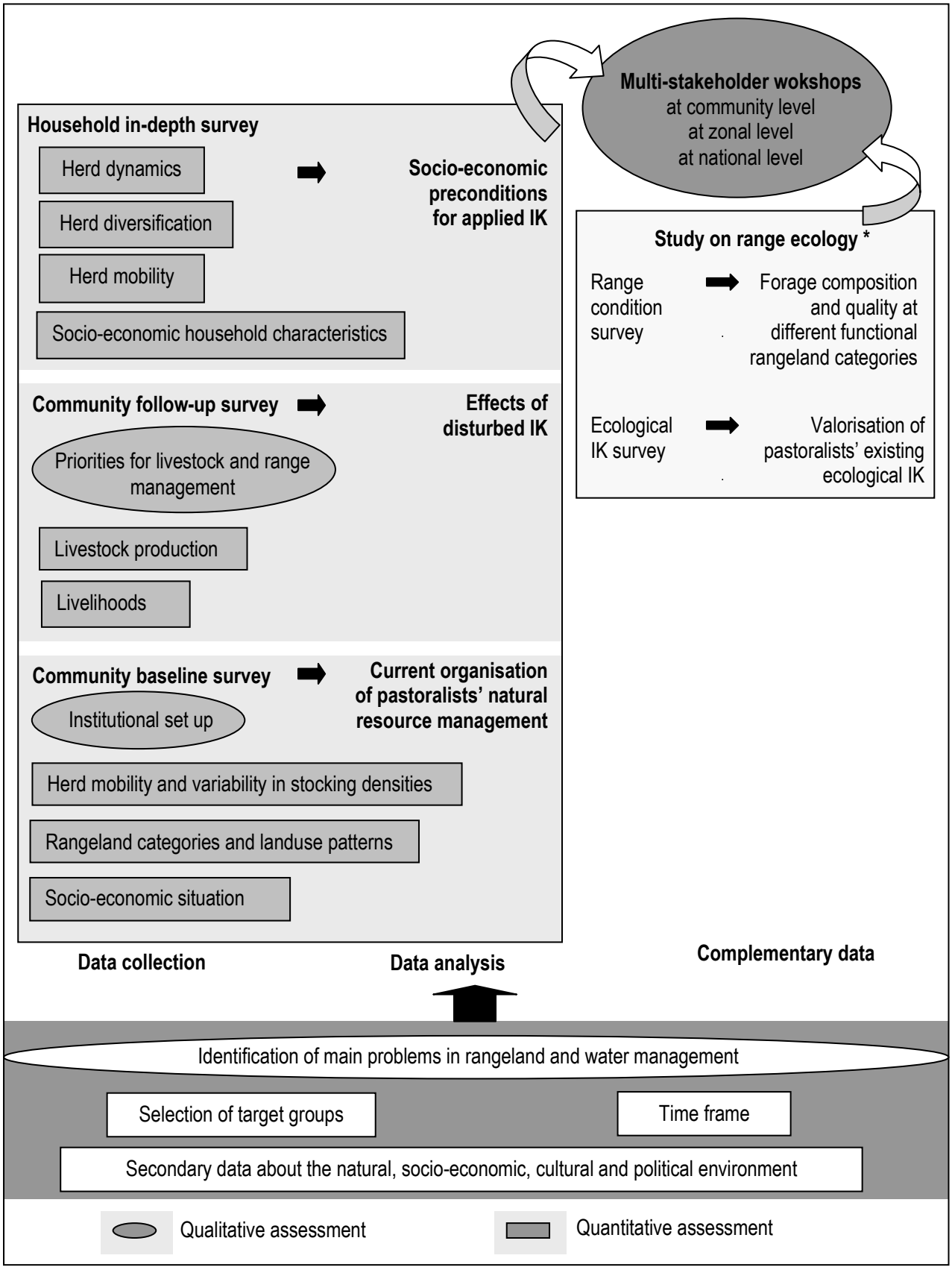


Figure 8. Research concept of the case study.

Source: Own design. Ecological investigations by Gemedo Dalle (*).

The multi-stakeholder workshops at the end of the field research were assumed as of particular importance, to justify the research investigations to the pastoral communities, to verify the findings so far and conclusions in the field, and to encourage the discussions about participatory development concepts for making use of the pastoralists' IK. The workshops were organised at the following levels:

1. Local community workshops in Dida Hara and Web: The communities were invited to delegate the participants for the workshop, following the Borana customs of sending experienced elders to meetings. They were kindly asked to include women.
2. Multi-stakeholder workshops at zonal-level in Negelle, capital of the Borana rangelands, and at woreda-level in Yabello, seat of local development agencies: Invited were representative elders and women of the local communities as well as governmental and non governmental organisations operating in the Borana rangelands.
3. Multi-stakeholder workshops at national-level in Addis Ababa: Invited were representatives from governmental and non governmental research and development organisations as well as from the pastoral communities. The research findings were presented and priorities for pastoral oriented development were explored jointly.

The approach of this study, combining quantitative and qualitative assessments within socio-economic and ecological disciplines, and being in close co-operation with the BLPDP/GTZ project, was expected to improve the understanding about pastoralists' priorities, adaptations and innovative strategies, and therewith to contribute to more genuine development concepts.

4 RESTRICTIONS OF PASTORAL INDIGENOUS KNOWLEDGE IN CURRENT NATURAL RESOURCE MANAGEMENT

4.1 HYPOTHESIS

Pastoralism in the Borana rangelands has developed under high risk conditions characterised by highly erratic rainfalls and recurrent droughts. Traditionally, the pastoralists have been successful in adapting to the highly variable natural resources, particularly forage and water. In this process, their IK was particularly valuable to establish flexible short term reactions and viable long term strategies which led to the opportunistic rangeland management. However, the natural-resource-based economy of Borana pastoralists has been disturbed by external interference. Especially the construction of water sources in rainy-season pastures had effects on grazing patterns and the location of encampments. This may have strongly affected herd mobility, a basic element of IK (Figure 1). It is hypothesised that the effect was even more profound:

1st hypothesis: **External interference in Borana rangelands ignoring pastoralists' indigenous knowledge destroys the basic preconditions of the applicability of IK-based range management strategies.**

To test this hypothesis, four research questions were elaborated.

1. What are the causes of disturbance to pastoralists using their IK? External interventions in the traditional system, namely water development, administrative changes, alienation of grazing areas and water sources, were assessed. The development in the density of the human population was analysed as an endogenous factor affecting the management of forage and water.
2. What changes in IK-based range management strategies can be observed in Dida Hara and in Web? An appropriate indicator had to be defined to verify the disturbed use of IK-based range management strategies. Pastoral production basically relies on the movement of livestock in search of meeting the nutritional requirements from the temporally available forage and water resources. Therefore, mobility was selected as indicator for the use of flexible land use strategies. Then, changes in herd movement patterns, linked to the changes in variability of stocking densities, and mobility at household-level as well as changes in the use of IK-based strategies directly related to mobility were assessed.
3. What is the impact of the disturbances on the basic preconditions for IK-based range

management of pastoralists in Borana rangelands? The utilisation patterns of the traditional rangeland categories, the functioning of the indigenous institutions and the related negotiation procedures were considered essential to the applicability of pastoralists' IK in modern natural resource management. In addition, socio-economic homogeneity was examined as an important precondition for the pastoralists to co-operate.

4. What are the consequences of reduced IK for the ecological rangeland conditions and for livestock production? The current ecological situation and the productivity of cattle, small ruminants and dromedaries were assessed.

4.2 METHODS

4.2.1 Data collection

The data collection in Dida Hara and Web started in December 2000 and was finalised in July 2002. A series of qualitative and quantitative methods of data collection was combined to answer the four research questions (Figure 8). In case of limitations for own data collection, secondary data were used for comparison and interpretation. In the following, the basic tools are presented; detailed information on target groups, objectives and guidelines of the respective interviews and technical measurements are presented in ATable 1.

To determine the causes of disturbance (first research question) qualitative methods of data collection were used: Introductory community meetings were organised at each encampment cluster (*ardaa*), held to explain the purpose of the study to the communities and to identify site specific problems in rangeland and water management from the pastoralists' point of view. The land use system today was compared with the situation about 30 years ago, before the development interventions took place. The discussions proved beneficiary for the establishment of a trustful communication during the research phase. Key person interviews with knowledgeable elders on land use history provided additional information. Apart from that, representatives from the government and local development organisations were interviewed on potentials and constraints for IK-based development.

Multi-stakeholder workshops at the end of the research phase (June-July 2002) were used to cross-check the identified constraints as well as priorities for future development interventions (compare chapter 3.7). In a first round, the workshops at the local-level in Dida Hara and Web were opened by introducing the purpose of the workshop and briefing the key findings of the research study. Then, the participants were asked to specify the main problems in rangeland

and water management, and to derive the root causes and to prioritise solutions. The participants were split in two groups for analytical discussions using participatory visualisation tools (PRA). The groups presented their findings and discussed the differences. The second round of workshops at zonal-level in Negelle and Yabello and at national-level in Addis Ababa started with a summarising presentation of the research findings. Then, the potentials and constraints to make use of Borana pastoralists' IK were explored by analytical discussions.

The changes in IK-based range management strategies (second research question) were measured by quantitative techniques of data collection. Participatory land use mapping gave an overview of the local infrastructure and principal land use categories. Then, the areas of the encampment clusters and related land use categories were measured by Geographical Positioning Systems (GPS) with the assistance of local range scouts (*aburro*). Several cross-checks were necessary to assure proper determination of distances and border points. Key persons from within and outside of the communities helped to recognise the traditional land use patterns on satellite pictures of Borana rangelands (Werner *et al*., 2001).

Herd mobility at landscape-level was identified by small group discussions with elders and herders at each of the selected encampment clusters in Dida Hara and Web. Seasonal grazing areas and current herd movement patterns were described for the home-based livestock (*lafa haawichaa*) and for the mobile satellite herds (*lafa gue'ssa*). Herd mobility at household-level was assessed by in-depth interviews with selected head of household (31 in Dida Hara and 29 in Web). The households targeted for the assessment of distances and frequencies in mobility were a sub-sample of the socio-economic baseline survey described in chapter 5.2.1. Data on mobility were collected for crisis driven movements during the late stage of the last drought (1999/2001), in comparison with subsequent movements after the drought (2001/02).

The variability of stocking densities was assessed also by small group discussions with elders and herders at the encampment clusters in Dida Hara and Web. Matrixes with seasonal stocking densities (Waters-Bayer and Bayer, 1994) were produced by estimating the number of livestock, which grazed daily the areas of the selected encampment clusters. They indicated the numbers of grazing livestock for the different seasons during a year of high stocking densities, (1997/98, before the last drought) and during a year of comparatively low stocking densities (2001/02, after the last drought). To facilitate the procedure, the pastoralists were first asked to estimate the number of cattle, small ruminants and dromedaries to be considered as a small, middle or large herding group. Then, they assigned a symbolic stone per group

onto a symbolic season field. The exercise also stimulated the discussion about local forage availability and grazing pressure.

The impact of the disturbances on the basic preconditions for IK-based range management (third research question) was examined by different quantitative and qualitative methods of data collection. Demographic information at the level of the encampment clusters was obtained from discussions with small groups of elders and herders. The Borana pastoralists' definition of the basic economic unit was used as reference for a household unit[44]. The discussions among the pastoralists were helpful to estimate the total human population, and valuable additional information came out.

A socio-economic baseline household survey relied on a sample of encampments (*olla*) and pastoral households (*warra*) within the selected encampment clusters (*ardaa*) (Table 1). Census data about the camps and the households were not available and pure random sampling was not possible. The selection of encampments was determined by distance to the centre of the encampment clusters. The household interviews were directed to the heads of the households who were available (*abba warra*). Biases in the sample of the head of households due to absence were minimised by starting the data collection in January 2001, at the end of the dry-season, when herders were usually available on the home-based grazing area. The sample included more households in Dida Hara (182) than in Web (58), in proportion to the larger population at Dida Hara.

Table 1. Structure of the sample selected for the socio-economic household survey.

	----------Dida Hara----------			----------Web----------		
Encampment clusters	Danballa Abba Chana	Dambi	Dikale	Kukub Y'aa	Daka Guracha	Nana
Distance to the centre (km)	4	8	12	3	6	9
Selected Encampments (n)	3	4	3	4	5	2
Selected households (n)	69	58	55	20	21	17
Interviewed households of the total (%)	35	22	17	57	95	35

[44] The corresponding level to a household was *warra*. The head of the household (*abba warra*) is accountable for proper herd management, livestock production and sale. He may have one or several wives. Female headed households were considered as one category of *warra*.

The socio-economic survey comprised semi-structured questions on the composition of the households and possession of livestock before and after the last drought. Further information, such as assets other than livestock, the educational standard, income generation activities and modes of co-operation, seasonal working schedules, the access to markets, relief and rehabilitation programmes, extension service and other development activities were used for orientation and cross-check of the socio-economic in-depth assessment of chapter 5. The questionnaire was tested on contents and on comprehensibility and was modified accordingly.

The pastoralists' perception of the current distribution of wealth was evaluated in small group discussions within the encampments (*olla*), similar to Waters-Bayer and Bayer (1994). The pastoralists defined livestock as the most important criteria for wealth. Then, they determined the local categories for the different strata of wealth and they estimated the share of the different wealth categories – each for the period before the drought and after the drought.

The changing impact of the pastoralists' indigenous institutions on natural resource management was discussed in subsequent community meetings, in Dida Hara and in Web. Following traditional principles of organising meetings, first the aim of the meeting was introduced to the communities of the selected encampment clusters. Then, they were asked to delegate competent elders for the meetings, to be held at the traditional meeting place in Dida Hara and in Web. The actual institutional arrangements compared with the situation about 30 years ago - before the beginning of the interventions from outside - were illustrated by Venn diagrams (Waters-Bayer and Bayer, 1994). The pastoralists were split into two equal groups and each group identified all institutions with relevance to natural resource management during the respective period of time. The relative importance of the institutions was symbolised by a large paper (strong importance), a middle sized paper (fair importance) or a small paper (little importance). The symbolised institutions were organised on a large sheet, where distances to the abscissa represented the frequency of contacting them. Finally, the institutions were arranged according to their functional interrelationships, and linkages were drawn for the most intensive institutional contacts. The groups presented the completed Venn diagrams mutually and discussed the differences. The discussions revealed extremely stimulating for the pastoralists to reflect the deteriorating institutional situation.

The thematic group discussions on changed herd movements as well as the discussions about indigenous institutions provided the information on the impact of development interventions on negotiation procedures. Further themes evolved during the research phase, which merited deeper investigation using semi-structured interviews with pastoralists from Dida Hara and

Web. The detailed rules and regulations for using water from deep wells and from newly constructed ponds were addressed to reputable water managers. The indigenous functional livestock categories were identified by interviewing young herders. Other topics were explored by small group discussions with elders and herders at both encampment clusters, like the comparative advantage of different livestock species, local breeding preferences and the appropriate herd composition, the minimum herd size and the minimum cultivated area in support of a household, and indigenous means to evaluate range conditions, to improve pasture and to prepare for drought.

The consequences of reduced IK for the ecological rangeland conditions and for livestock production (fourth research question) were assessed by quantitative techniques of data collection. Live-weights of different age categories of cattle and local breeding types were recorded by field assistants during the peak dry-season in February 2002 and the peak rainy-season in June 2002. The animals were randomly selected among the home-based herds in Dida Hara and in Web, using a representative subset of about 543 total cattle, including male and female cattle from each production category. The bodyweights were estimated from girth circumference.

Livestock progeny history (Kaufmann, 1998) was recorded for female breeding animals of 453 cattle, 217 goats and 183 dromedaries, with similar sample sizes in Dida Hara and Web. The field assistants contacted the owners of home-based herds in Dida Hara and Web. The herd owners were asked to select breeding females with a minimum one parturition. The animals were registered by their name and age. Data on the breed, mode of acquisition, milk production[45], reproductive performance, and health problems including abortions of each selected animal were recorded. Furthermore, the date of birth, sex, age of weaning, whereabouts and health of all the calves were noted. The data were based on pastoralists' memories, and indicate trends rather than providing accurate numbers.

The ecological data were collected and analysed by Gemedo Dalle (in Homann *et al.,* 2004). Dalle compared the rangeland conditions of different functional rangeland categories, using methodology adapted from Baars *et al*. (1996). Herbaceous bio-mass production, species

[45] The current milk off-take was estimated from pastoralists estimation of the average daily milk yield (number of milking cups (*qorqi*) containing about 0.3 l) during the past lactation period, and cross-checking with pastoralists' ranking of the females in high, middle or low milk production for human needs.

composition and density of grasses and woody plants, as well as soil conditions were quantified along transects. Complementary to the quantitative assessment of rangeland conditions the pastoralists' ecological IK on rangeland conditions was investigated on the same sites. Methods used for documenting pastoralists' ecological IK included group discussions, semi-structured questionnaires and key person interviews.

4.2.2 Data processing and analyses

Geographical Information Systems (GIS) techniques facilitated the design of land use maps, the calculation of the area and derivation of population densities. For the illustration of the traditional land use patterns in Borana rangelands the depicted traditional land use categories were merged with the satellite pictures in a digital format (Werner *et al*., 2001). Scanned maps of the formal administrative division (*woreda*) in Borana rangelands at the time of the field research were integrated. The qualitative information about Borana pastoralists' traditional land use were recorded and reviewed to describe the typical Borana land allocation system as shown on the map. The processing of the map was done in CorelDraw 9.0. For the maps of the current land use the GPS measurements of the encampment clusters and the land use categories were digitised by ArcInfo and processed by ArcView. Quantitative data about land use categories, human populations and population densities were analysed by descriptive statistics.

The variability of stocking densities in Dida Hara and Web was compared by calculating the coefficient of variation[46] of the estimated seasonal stocking densities of cattle, small ruminants and dromedaries (TLU km^{-2}). The current variability of stocking densities was calculated, for the year before (1997/98) and the year after the last drought (2001/02), and it was compared to the variability in stocking densities, derived from the pastoralists' narratives for the time before the disturbance, about 30 years ago.

The herd mobility at household-level was measured by calculating the monthly walking distances per each livestock species, during the late stage of the drought (March 1999 – February 2001) and after the drought (March 2001 - February 2002). Then, the mobility at household-level was compared, between Dida Hara and Web, and during the two observation periods, by categories of low, medium and high mobility. The procedure for the classification

[46] The coefficient of variation (%) is calculated by the ratio of the standard deviation to the mean.

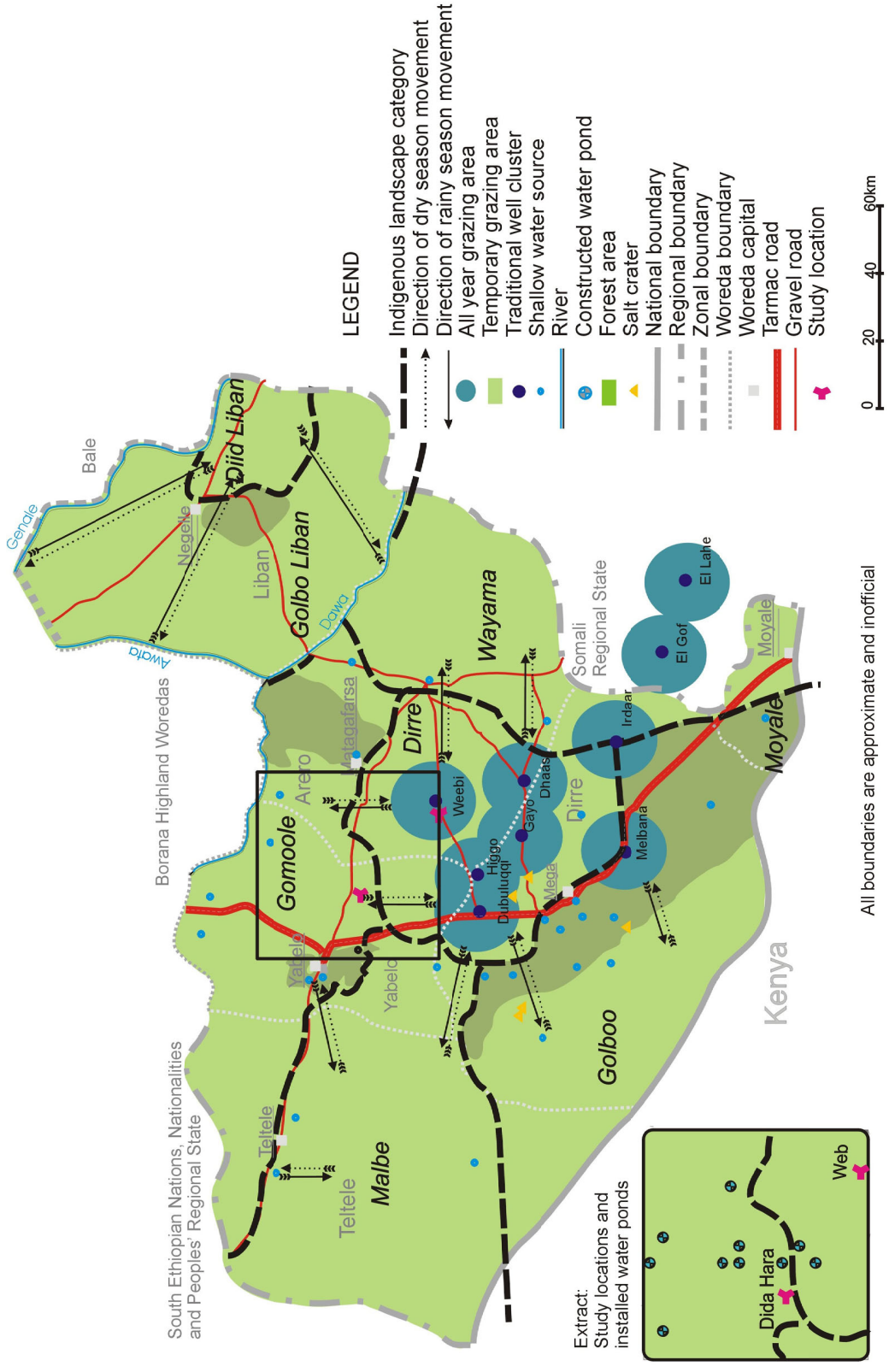
of mobility is described in chapter 5.2.2.

The disturbance to mobility was explored by integrating pastoralists' explanations with the quantitative research findings. The historical narrative information about the context and the process of changing natural resource management was structured to define the principal causes for the reduced mobility. Finally, the disturbance to mobility was set in causal relation to the basic preconditions for its applicability. By means of descriptive statistics the current environmental and socio-economic conditions were characterised.

4.3 RESULTS

4.3.1 Disturbances to Borana pastoralists' use of indigenous knowledge-based range management strategies

The results derived from qualitative interview techniques (A1, A2, A15, A16 in ATable 1) allowed to identify the following external interventions as most disturbing to IK-based range management strategies: The construction of permanent water ponds in former rainy-season grazing areas starting the early 1970s has severely disturbed pastoralists' herd mobility and thereby reduced the variability in stocking densities (compare chapter 4.3.2). During the initial group discussions on problematic changes in land use practices Borana pastoralists' had repeatedly stated, that the permanent access to water in the *Gomoole* area broke the exigency of mobile resource exploitation (Map 4). Elders and herders from Dida Hara explained that providing areas like Dida Hara with permanent water and having easy access to abundant pastures made movements of herds back to areas such as Web in the dry-season no longer necessary. The wealthy owners of large mobile herds were reported as the first to establish their permanent encampments in Dida Hara, and the former rainy-season grazing area was gradually converted into permanent grazing. Elders from Web testified that mainly the smaller herd owners had remained in Web. Those herders who remained in Web were deprived from the best rainy-season grazing areas for their satellite herds, while during periods of water scarcity Web still has to cope with the demand of external herds. During recent years impoverished households have settled in areas near the wells without respecting the traditional pasture regulation. The restricted herd movements increased the grazing pressure in Web.



Map 4. Indigenous land use patterns in Borana rangelands, southern Ethiopia.

Source: Author, based on pastoralists' interpretation of satellite pictures provided by Werner *et al.* (2001)

Development experts reconfirmed, that the continuous opening of water points in pastures formerly used only temporarily has induced the expansion of permanent encampments throughout the region, but was not appropriate to accommodate pastoral range management (Milliyoon Sabsibee, SORDU infrastructure development; Atlaw, SORDU range expert; Omar Gobe, Zonal Administration, pers. comm., 2001).

Pastoralists have further observed that mainly after 1992, the delivery of famine relief at the well complexes in Web as well as at the centre of newly constructed encampment clusters in Dida Hara enhanced the development of towns, attracting further encampments and trade. During the research phase in 2001, a water borehole was established by governmental support, at 35 km distance from the Web wells and in pastures formerly reserved for dry-season grazing, including the foundation of a new Peasant Association (PA). The implementation was controversially discussed within the Web communities, and the further expansion of permanent encampments was criticised. Uncontrolled encampments are seen as a major impediment for the use of mobility and variable stocking densities.

According to the results obtained from key person interviews with elders and group discussions with elders and herders (A1, A2, A14, A16 in ATable 1), the implementation of the peasant associations (PA) by the government since the late 1970s counteracted the indigenous institutions. The PAs are the formal units for political administration at the local-level and are subordinated to the woreda administration in Yabello and Arero for Dida Hara and Web, respectively (compare chapter 3.5). Throughout the Borana encampment areas, younger community members, inexperienced in rangeland management, were appointed and given the powers of decision making at the local-level. They concentrated on public security and political control, but gave little consideration to the rangelands. The elders' committees were excluded from decision making and hence no longer able to apply their knowledge. This has caused conflicts between generations within the communities, and has destroyed the networks by which the Borana pastoralists governed the access to pasture and water resources.

During analytical discussions (A1, A2, A16 in ATable 1) Borana pastoralists repeatedly accused the formal alienation of most valuable grazing and water resources by the regionalisation policy of the Ethiopian Federal Government as a direct deprivation of their properties, causing destitution. Borana elders explained in key person interviews that after the hand-over of power to the new government in 1992, the federal regionalisation policy transferred large parts of the *Wayama,* about one third of the Borana land, and two important

well complexes to the Somali. The new borders effectively impeded access of Borana pastoralists to these valuable rainy-season resources. The Borana pastoralists considered the borders as legal oppression by the Ethiopian Federal Government, being biased towards the Somali Regional Government, and ignoring traditional mechanisms for reconciliation. The ensuing socio-economic and political instability have led to violent clashes between Borana and Somali communities. The grazing areas at the border were contested and occasionally evacuated. According to own observations, the aggressions between the two ethnical groups got worse during the phase of the field research, and manifested more in Web area adjacent to the eastern *Wayama* area. Military presence and aggression against the Borana population was observed in Web. Elders and herders in Web complained that most valuable grazing resources were repeatedly excluded from utilisation. This was interpreted by the Borana pastoralists as an abuse by the Ethiopian government to consolidate power. At the multi-stakeholder workshops Borana pastoralists stated that solving the conflicts has passed beyond their capacity and that the government is now responsible for conflict management. However, the role of the government in conflict solving or having an interest to fuel the conflicts was judged ambiguous.

The results from discussions in Dida Hara and Web, cross-checked at the multi-stakeholder workshops (A1, A2, A16 in ATable 1), attested that further development interventions in the Borana area were directed against pastoral range management (compare ABox 5):

1. The Ethiopian land use policy has favoured sedentarisation. The PA administration and extension services promoted crop cultivation as a means to settle the pastoralists, regardless of the agro-ecological disposition of the Borana rangelands. Precursory interviews with administration and extension officers at the local-level had revealed their ignorance of pastoral livestock production and the lack of capacity to support pastoral land use strategies. The extension messages were not appropriate to the needs of the pastoralists. Borana pastoralists have observed crop cultivation taking off valuable key resources from livestock production, adsorbing labour from herding and contributing to the negative attitude towards moving with the herds.
2. The Ethiopian government had also issued a proclamation to ban the burning of highland forests, and applied it equally to the pastoral rangelands. According to expert's information given at the multi-stakeholder workshops, the ban has never been formalised and no guidelines exist for the rangelands. Thus, the ban was implemented in pastoral areas without legal authorisation, and was de facto illegal. Borana pastoralists complained

that heavy sanctions through PAs and woreda administration restricted them from using the most effective tool to prevent woody species encroachment and maintaining healthy grazing conditions for their livestock.

3. The terms of trade for livestock were unfavourable compared to grain and the investment in livestock marketing is insufficient. Borana pastoralists reported that their own efforts in creating new market places for sale of livestock were labelled illegal. Cases were recalled that local markets have been burned down in the name of the formal administration.

4. The establishment of commercial ranches counteracted the Borana common property system and initiated the privatisation of common rangelands. The Borana pastoralists rejected ranching as not suitable for a proper preservation of the rangelands.

5. The drought and disaster mitigation operated with food aid, herd restocking or provision of tools for bush clearing was realised by NGOs and has repeatedly been abused for political manipulation through the PAs and woreda administration. It has not yet been conceptualised towards a structural change for sustainable livelihoods. In the words of Doyo Dulascha, a Borana elder from Dida Hara (pers. comm., 2001): *"Food distribution is a remedy which quickly fills our stomach, but it creates our dependence on the donors, and is not invested to improve our life.*"

The development of the human population was considered as endogenous factor, which exerted further pressure on the remaining rangelands. Recent data on population density are not available. Evidence for large increase are figures on the human population growth, the expansion of permanent encampments in formerly only temporarily accessible grazing areas, and comparing the distribution of the human population in Dida Hara and Web. The net annual growth rate of the Borana population has increased from 1 - 1.3% at the beginning of the 1970s, to about 2.5% since the late 1980s (Coppock, 1994). The rapid expansion of permanent encampments in the rainy-season pastures is clearly shown by the GPS measurements (A17 in ATable 1, Map 4Map). The encampment clusters of Dida Hara are located in the *Gomoole* rainy-season grazing area where before 1970 few permanent encampments have existed (SORDU, unpublished documents). The permanent encampments themselves were larger in Dida Hara with an estimated average of 44 households per encampment, compared to Web with an average of 7 households per encampment (A11 in ATable 1) or to Coppock's (1994) estimation of on average 10 households per encampment. Own estimations in Dida Hara and Web further attested, that the human population has heavily expanded in the former rainy-season pastures (Table 2; ATable 4). Dida Hara, the

estimated total human population was almost ten times larger than in Web. The population density in Dida Hara reached similar values like in Web, due to a larger common grazing area (ATable 6; Table 5).

Table 2. Average demographic characteristics (n), and human population density (n km^{-2}) in selected encampment clusters in Dida Hara and Web.

Demographic characteristics	Dida Hara	Web
Encampments[1]	30	13
Households[1]	788	111
Female headed households[1] (%)	122 (16)	18 (16)
Polygamous households[1] (%)	40 (5)	5 (5)
Human population[2]	5169	732
People per households[2]	6.6	6.7
Human population density[2]	21	25

[1] Source: Discussions in small groups on the socio-economic situation (A11 in ATable 1), including studied and non-studied encampments.
[2] Source: Socio-economic baseline survey (A12 in ATable 1).

The calculations of current population densities were based on the permanent grazing areas close to the encampments (*warra*), and did not include the only temporary accessible grazing areas (*foora*). However, under the current conditions of encampments expanding into rainy-season pastures (*foora*) and a reduced mobility the estimations get very near to the real situation. The current population densities were much higher than twenty years ago, when Upton (1986) based on aerial surveys estimated an average human population density of 6 persons km^{-2}. They match with estimations of human population densities in semi-arid East Africa for the 1990s with an average of about 21 persons km^{-2} (de Lew and Ray, 1995). Kamara (2001) even found an average population density of 46 persons km^{-2} by community assessments, with the highest population density in Dida Hara at 103-160 persons km^{-2}. His findings referred only to encampment areas, and in a case like Dida Hara did not account for the balancing effect of the adjacent permanent grazing areas.

According to the criteria of Upton (1986) a pure semiarid subsistence system could support a human population of at most 5 persons km^{-2}, and this was exceeded by far in all sampled clusters. Thus, the pastoralists have to rely increasingly on external inputs to the available grazing area, either by moving their herds to sufficient supply of forage, or by importing forage, or by income generation other than from livestock. Under current conditions, any reduction of the per capita availability of natural resources would be directly threatening the population with poverty.

4.3.2 Reduced use of indigenous knowledge-based range management strategies in Dida Hara and Web

Results from qualitative and quantitative assessments showed that range management in the Borana rangelands has changed considerably since the beginning of external interference. The descriptive information obtained from Borana land use mapping and land use history (A1, A2, A3 in ATable 1) showed that traditional land use patterns were in practice 30 years ago, when the Borana pastoralists followed a semi-sedentary mode of production, based on movements of the cattle and the herders (compare Map 4). The permanent encampments were kept clustered near to the traditional deep wells (like Web), the only source with a permanent supply of water. Herds of mainly lactating cows were retained on the adjacent pastures (*warra*), at maximal grazing distances of 30 km. Satellite herds with non lactating cattle were split off to move to temporary camps at the more distant pastures (*foora*) (like Dida Hara). The total distance between the permanent encampment and the satellite camp could reach about 100 to 150 km. The satellite herds moved out from the all year pastures around the deep wells such as Web at the beginning of the main rainy-seasons, and returned at the start of the dry-season. The main time for the long distance movements was during the big rainy-season (from March to May). Smaller fluctuations occurred during the small rainy-season with good rainfalls (from September to November). During dry-seasons (from December to February) the lack of surface water forced the herds to draw back to the pastures near to the wells. Then, the herds of lactating cows were grazed at an inner circle to the wells, and the satellite herds were kept at the outer margins, as they could easier walk the long distance of about 40 km between the dry-season pastures and the wells. Consequently the grazing pressure was reduced around areas such as Web during the rainy-season. In areas such as Dida Hara hardly any animals were found in the dry-season due to the lack of water.

Although figures about stocking densities in the former grazing system are not available, it can be assumed from the pastoralists' explanations that the seasonal grazing system produced highly variable stocking densities in Dida Hara and Web[47]. The stocking densities reached the highest values at the end of the dry-seasons in Web, when the herds grazed near to the

[47] Note, that Dida Hara and Web represent examples of grazing areas with a different traditional functionality, which were integrated in the Borana range management system. The variable stocking densities resulted of livestock fluctuations at a large-scale, but they were not necessarily linked to mobility between specific areas.

traditional deep wells. They were lower during the rainy-seasons, when the satellite herds were dispersed in the peripheral grazing areas like Dida Hara. The peaks in seasonal stocking densities were more or less pronounced, depending on annual rainfall conditions and stocking densities pertaining to the entire Borana rangelands. Range management in the Borana rangelands was thus organised at a large-scale of the landscape, making use of mobility.

With the construction of water ponds - with high water supply and close in distance - in the traditional rainy-season pastures (*foora*) the system changed (compare extract in Map 4). As explained in chapter 4.3.1 permanent encampments were founded in former rainy-season grazing areas (like Dida Hara), herds in the traditional dry-season grazing areas became increasingly confined to pastures closer to the wells (like Web), and permanent grazing replaced seasonal movements (*warra*) (Photo 1, Photo 2). With the expanding human population grazing pressure also increased. Tensions between communities were reported in Dida Hara and in Web, due to the restricted movements and increasing scarcity in pastures to meet the needs of the lactating herds. At both locations herds remain near to the encampments, as the pastures for walking and grazing became intersected by encampments and other forms of land use (compare chapter 4.3.3.1). The observations from Dida Hara and Web indicate that the practice of maintaining a permanent encampment and splitting off satellite camps is more and more abandoned. The functional distinctions between all year grazing areas (*warra*) and the rainy-season pastures (*foora*) become eroded. This induces a break-up of the former long distance movements and separate grazing systems evolve in Dida Hara and Web.

Photo 1. Cattle on the way to daily grazing at encampment clusters in Dida Hara (*warra*).

Photo 2. Cattle grazing at remaining rainy-season pastures near Dida Hara and Web (*foora*).

To confirm this picture, the current variability of seasonal stocking densities in Dida Hara and Web, systems with different functionality in the traditional land use system, was investigated (A7 in ATable 1). Seasonal stocking densities were estimated from the total of in- and out-moving herds within the observation period and the coefficient of variation was used as an indicator for variability. The spatial units of reference were the total grazing land for the lactating herds of the selected encampment clusters (ATable 6). The results showed that the stocking densities varied between locations and seasons (Table 3). Web, the former location of permanent encampments, had still a higher stocking density (121 TLU km^{-2}) than Dida Hara (26 TLU km^{-2}). Due to the drought cattle pressure was reduced by 58% (Dida Hara) and 60% (Web). While in Web, a seasonal pattern was still evident, as most herds were grazed the long dry-season, little, if any variability was recorded for Dida Hara, indicating a reduced mobility, which was further reduced after the drought. Therewith the coefficients reflected the trends that IK based range management was applied in Web but was reduced in Dida Hara.

Table 3. Estimated seasonal stocking densities (TLU km^{-2}), means and coefficients of variation (%) measured for a year before and after the drought in encampment clusters of Dida Hara and Web.

Encampment cluster / period	Severe dry-season (Dec-Feb)	Big rainy-season (Mar-May)	Small dry-season (Jun-Jul)	Small rainy-season (Aug-Nov)	Mean	se	CV
	[TLU km^{-2}]						[%]
				Dida Hara			
Before drought (97/98)	42.8 [a]	33.1 [a]	34.4 [a]	34.5 [a]	36.2 [a]	2.2	12.4
After drought (01/02)	15.4 [a]	15.4 [a]	15.4 [a]	15.1 [a]	15.3 [a]	0	0.7
Mean	29.1	24.3	24.9	24.8	25.7		
				Web			
Before drought (97/98)	338.2 [b]	101.3 [b]	147.5 [b]	105.2 [b]	173.0 [b]	56.0	66.0
After drought (01/02)	117.7 [b]	28.9 [b]	124.8 [b]	9.1 [b]	70.1 [b]	29.8	86.9
Mean	227.9	65.1	136.1	57.1	121.5		

[a,b] Means in rows followed by different subscripts are significantly different at $p<0.01$

The assessment of the herd mobility at household-level (A6 in ATable 1) confirmed the findings from the previous section. The monthly distance in herd movements aggregated for

all livestock species was between 0 and 108 km, and for cattle between 0 and 70 km[48] (Table 4). High maximum distances were measured in Dida Hara and in Web during and after the drought, but the median distances were much smaller. At both locations, single households performed long distances, but the majority kept the herds fairly stationary. The median[49] herd mobility was similarly pronounced in Dida Hara and in Web during the drought, as in both locations the movements were driven by crisis. After the drought, the high losses in livestock have resulted in sufficiently available forage resources to feed the surviving herds, and water was also plenty. Mobility was significantly higher in Web than in Dida Hara (median test, $p<0.05$), as movements in Dida Hara were significantly reduced (algebraic sign test, $p<0.01$).

Table 4. Household's herd movements (distance in km month^{-1}) in Dida Hara and Web during and after the drought.

Move-ments	----------Dida Hara----------			----------Web----------		
	During drought (99/01)	After drought (01/02)	Diffe-rence(%)	During drought (99/01)	After drought (01/02)	Diffe-rence(%)
	[km month^{-1}]		[%]	[km month^{-1}]		[%]
			Total herd			
Median	16	0	-100	19	10	-47
Min	0	0	0	0	0	0
Max	111	108	-3	102	70	-31
			Cattle			
Median	12	0	-100	13	9	-31
Min	0	0	0	0	0	0
Max	47	45	-4	42	70	67

The distance in movements categorised into ranks of mobility reconfirmed that there was no significant difference in mobility during the drought between Dida Hara and Web. After the drought, mobility was higher in Web than in Dida Hara (χ^2-value = 16.7, $p<0.01$) (Figure 9). While no herds with high mobility were found in Dida Hara, 20% of the herds in Web showed high mobility.

[48] The distance in herd movements was calculated for all species to account for the efforts made by households who moved several groups of livestock.

[49] The median was selected as most appropriate to indicate the average mobility, being less influenced by extreme high values as the mean could do.

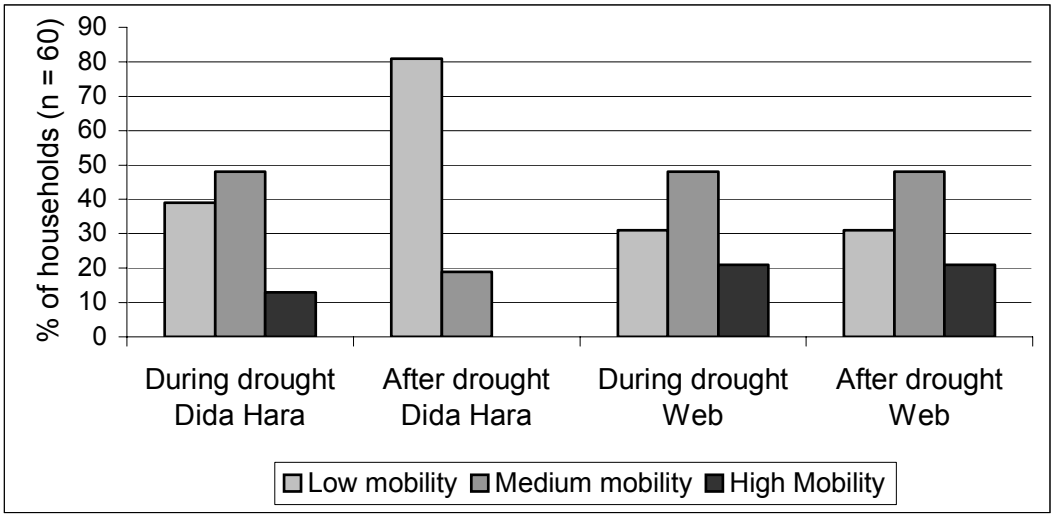


Figure 9. Household's frequency of mobility in Dida Hara and Web during and after the last drought (compare ATable 2 for definition of low, medium and high mobility).

The hard facts on reduced mobility and variability in stocking densities were confirmed by pastoralists' descriptive information. Current movement patterns were said to be more short-term oriented, to follow the scattered forage resources where they emerged. They were in direct response to the rainfall, and common directions for seasonal herd movements were hardly observed ("*Today, we face disorder of movements. Nobody decides about any direction of movements. We do not split into home-based grazing area (warra) and temporary grazing area (foora). There is no place, neither to move on good pastures or to avoid drought, nor to allow the land to rest or to apply burning. Instead, we just listen about the rainfall conditions. Then, we have to move the herds immediately, to follow the rain and to get the pasture. The owners of many cattle face also big problems. All area for their dry livestock is occupied by encampments. We cannot prevent them from the home-based pastures, if the foora land is not free from encampments.*" Gujo Jatani, Borana elder from Dida Hara, pers. comm., 2001).

Pastoralists in Dida Hara explained (A1, A2, A3 in ATable 1), that the overwhelming majority of the households used to graze their herds in the vicinity of the encampments throughout the year, at a daily grazing radius between 5 and 8 km. Under normal conditions the necessity to move was low. But during the drought (1999/2000), the herds in Dida Hara experienced a particular difficulty to find water. Then they had to walk about 45 km distance to the remaining ponds. Only a minority of wealthy households could move their herds out of the home-based grazing area. They maintained several encampments at distances up to 30 km, where they used to shift the herds to more favourable forage and water conditions. In

comparison, pastoralists in Web reported that seasonal herd movements towards favourable grazing areas are always necessary. During rainy-seasons, households join to move parts of their herds to remaining productive pastures and external herds have to leave the area. During dry-seasons herds from Web search for pocket areas where grass has been preserved, while external herds come in. During both seasons, the walking distances for herds from Web reached about 30 to 40 km between the grazing and water resources.

The comparison of the current grazing systems with the situation 30 years ago therefore clearly shows that the community-based long distance movements have been interrupted. In most cases, short distance movements prevail. According to pastoralists' explanations (A1, A2, A3 in ATable 1), the most common option to move was to insert one's livestock into the herds belonging to other encampments, in a different and possibly more favourable area. Thereby a household gained access to pastures who belonged to that encampment, when the own grazing area was depleted. This option was said to depend on strong social relationships among single households and it certainly contributed to an increasing grazing pressure on the pastures near the encampments which were previously preserved for the lactating herds (*warra)*. However, there were still a few under-utilised rainy-season pastures (*foora*) in *Malbe* and in *Wayama*. Unfortunately, full use of the *Wayama* pastures was repeatedly restricted due to the conflicts with the Somali (compare 4.3.1). The pastoralists have observed that this under-utilisation of the *Wayama* pastures has already caused rangeland degradation by woody species encroachment.

According to the pastoralists' information (A2, A8, A9 in ATable 1), the reduced mobility has negative consequences on the use of directly related practices: The lack of accessible pastures renders the evaluation of rangeland condition scores (*finna*)[50] superfluous. The expertise in leading the cattle to pastures of good forage value was formerly based on continuously updated information and evaluation of alternative grazing areas by commonly appointed range scouts (*aburro*). Today, the practice to delegate scouts to other areas to collect information about climate, forage and water availability, disease outbreaks and warship, has become rare.

[50] *Finna* is a complex indigenous score for evaluation of the actual rangeland conditions. *Finna* is process-oriented because it is based on perceptions of the seasonal and the long term trends in climatic conditions. It is situation specific because it integrates aspects like water quality, disease prevalence and livestock specific grazing preferences. *Chiissa* is an indicator which refers only to the abiotic properties of an area. *Gabinna* reflects the criteria for the rangeland evaluation, the behaviour, products and productivity of livestock.

Abandoning the monitoring of the range conditions certainly reduces the intimate observation of cattle's behaviour and constitution as the main indicators of favourable grazing conditions ("*Formerly we understood the environment by collecting information from many channels. Then, we checked the local grazing conditions by sending a scout (aburro). The whole encampment (olla) came together to decide about the grazing area and the aburro to be sent. He had to be an experienced person, who knew to evaluate the conditions of an area (finna), interpreting range conditions and animals' behaviour and health conditions, and making sure that there was peace. Today we cannot follow the good finna, because the grazing areas are restricted"*. Dureti Wario, Borana elder from Web, pers. comm., 2001)

Borana pastoralists pointed out, that the indigenous structures for information transfer and decision making have been weakened. Formerly, decisions about range management, as well as social assistance and political issues, were based on flexible negotiation networks between delegated elders. Today, the thematic meetings and regular assemblies about rangeland evaluation and negotiation of appropriate strategies were said to be practised less often. At the encampment-level, the daily pooling of information and labour for mutual herding (*dhawa*) and watering livestock (*jaasuma*) has been reduced, and discussions between herders about where to move the herds (*marri looni*) have become less frequent. Local land use planning became diluted by diverging interests. At a larger scale of the Borana rangelands, the negotiations about how to use the common rainy-season pastures are completely abandoned (*kora dheedaa*). The clan-based convocations for rehabilitation of clan members deprived by drought take place (*kora debanu*), but become less effective. The pan-Borana assembly (g*umi Gaayo*) has lost in power to influence the development in Borana rangelands.

Borana pastoralists further explained that different supplementary strategies were traditionally used to enhance rangeland and livestock production, but have been almost completely abandoned: The controlled burning of the rainy-season pastures was intended to accelerate the regeneration of most palatable forage grasses, and to provide forage for cattle after the dry-season. Therefore, sites of high grass production were determined by the responsible elders committees. Fire was set under appropriate climatic conditions with suitable wind, when rainfall was expected soon and when sufficient fuel load from dried grass was available. It was controlled by firebreaks (*kara ebida*). Certain areas were known for their particular productivity and were burned every year (*guba*), other parts were burned every second year (*gursumeessa*) and others after 3-4 years (*furra*). Since the governmental ban on burning was transferred to the Borana rangelands and harsh sanctions were imposed, the practice of

rangeland burning was abandoned. The pastoralists blame the cease of burning for woody species encroachment, for the expansion of predators and for parasite induced health problems. Under the current conditions pastoralists still recommend burning for range rehabilitation, but regard burning as less applicable due to the lack of sufficient fuel load and the risk to set fire on the scattered encampments.

Extending the grazing time to the early morning hours (*warree)* was used to enhance the forage intake of the cattle dispersed on the rainy-season pastures. At the beginning of the rainy-season cattle were moved out for grazing from 10 p.m. to 5 a.m. and 8 a.m. to 6 p.m. to compensate weight losses during the dry-seasons. In the later rainy-season the grazing time was gradually changed, from 1 a.m. to 6 a.m. and 10 a.m. to 6 p.m., to increase milk yield, reproductive performance and fattening. However it was said to be not practicable, because the insufficient forage resources for rainy-season grazing would not remunerate the efforts, because the effect of trampling moist pastures would enhance further degradation and because a higher productivity would be at the expense of drought resistance.

Switching between the different water sources from the deep wells and the surface water in rainy-season pastures was recommended for good animal nutrition. The water from the deep wells during dry-seasons was considered as indispensable for good physiological condition, and to provide a better strength to survive droughts[51]. Whereas, the reliance on surface water only, was said to cause a weak constitution of the cattle. However, the construction of water ponds dispensed the temporally restricted drinking at open surface water. A comparative chemical analysis of the water from wells in Web and from the neighbouring Higgo wells with water from the Haro Bakke pond in Dida Hara revealed lower pH and lower concentration of calcium and magnesium of the pond water (ATable 7).

Different salt feeding regimes were traditionally applied to sustain livestock performance and to assure their good physiological condition. The different types of salt sources were naturally available. They were known for livestock-specific benefits and chemical analysis confirmed their different nutritional composition (ATable 8). Frequency and amount of salt feeding varied seasonally, with a peak in the rainy-season. However, important rainy-season pastures in *Wayama* with a vegetation of high salt content were no longer accessible for the herds due

[51] In the pastoralists' narratives, the cattle from Web were praised for particularly well prepared to cope with drought, thanks to the consumption of the high quality water from the wells.

to the transfer of land to the Somali and related conflicts. The extraction of high quality salt from the volcanic craters has been commercialised and poor households often lack the capacity for purchase and transport of the salt.

4.3.3 Impact on basic preconditions for indigenous knowledge-based range management strategies

From the descriptive information obtained during group discussions and key person interviews with Borana elders and herders, the most important preconditions for IK-based range management strategies were identified, namely the Borana pastoralists' ecological classification of the rangelands and resulting utilisation patterns, the indigenous institutional framework and negotiation patterns as well as socio-economic equity.

4.3.3.1 Ecological rangeland classification and utilisation patterns

The pastoralists' historical information on rangeland classification and interpretation of satellite maps (A1, A2, A5 in ATable 1) showed distinct ecological zones in accordance with the characteristics of the natural resources (indigenous landscape categories in Map 4Map). Accordingly, the entire Borana zone was separated into two major grazing systems, *Liban* and *Dirre*. The *Liban* system represented the area north of the Dawa River, and traditionally it had mainly a religious importance for accommodating the ritual celebrations of the Borana. Within *Liban*, the herd movements were limited to *Golbo Liban* for dry-season grazing near the river. During rainy-seasons the herds were moved to graze the plain grasslands in *Diid Liban.* The *Dirre* system referred to the entire area south-west of the Dawa river and included the sub-area *Dirre* around the wells, and the peripheral areas *Malbe, Gomoole, Wayama* and *Golbo*. The *Dirre* system represented the typical Borana rotational grazing, between the main sources of permanent water and extended grasslands. Central to the *Dirre* system were the traditional well complexes (*tula sagalaani*), concentrated in the sub-area *Dirre*, along a valley of white soil. The Web well complex was among the oldest, with a good water quality adjacent to an open grazing area in eastern direction[52]. The permanent water supplies attracted numerous cattle herds from all directions during the dry-seasons. The temporary high pressure of livestock was slightly eased by the use of smaller shallower wells (*adadi*) at the peripheral

[52] A Borana proverb compares Web wells with 'a mother of an elephant', expressing a source of experience, endurance and vitality (Borbor Bule, Borana elder from Dubluq, pers. comm., 2001).

rangelands. Therefore, the sub-area *Dirre* was classified as an all year grazing area. It was surrounded by vast grazing areas, which were only accessible during rainy-seasons, and therefore classified as temporary grazing areas. Among them, the *Wayama* plain grasslands were known to be of greatest value for cattle. These areas have a wide flat topography with fertile soils, which provided an abundance of high quality natural pasture. Also favourable for cattle were the areas to the north, known as *Gomoole*, to which Dida Hara belongs[53]. Fewer herds were moved to the south, the *Golboo*, which were known as more suitable for small ruminants, and the central parts of *Malbee*, which also attracted herds from the lowland valleys of the surrounding mountain chains. Additional sources of forage were the forest areas. They were traditionally used as an important source of dry-season pasture and water, either by occasionally moving the herds or by cut and carry. The forests also bear a spiritual significance for ceremonies and are important for the Borana cultural integrity. They are defined benchmarks for ritual migrations, exercised by special branches of the traditional governance, the *gadda.* Salt sources prevailed in different forms, sporadic as soil component, in vegetation and water, and in large amounts at volcanic craters. They attracted herd movements occasionally during rainy-seasons, or the salt extracts were transported to the herds.

The Borana pastoralists in Dida Hara and Web explained (A1, A2, A5 in ATable 1) that herd movements in the *Dirre* system were directed by rules and regulations for the access to the different rangeland categories. The functions of rangeland were basically differentiated in land for permanent encampments (*lafa tesso*) and land for movements (*lafa godann*). The grazing areas were strategically partitioned and provided pastures close to encampments (*warra*) - which were mainly located in the central sub-area *Dirre* (all year grazing area in Map 4Map, - and at satellite camps (*foora*) (temporary grazing area in Map 4) - which extended throughout *Wayama*, *Gomoole*, *Malbe* and *Golboo*. The access to the different rangeland categories was dictated by the limited availability of water during the peak dry-season. The main encampments (*warra guda*) and adjacent pastures for the common use of the lactating herds (*lafa haawichaa*) were clustered at the dry-season centres - such as Web - and confined to a line at a distance of 10 to 15 km around the wells (*dongora seera*). The

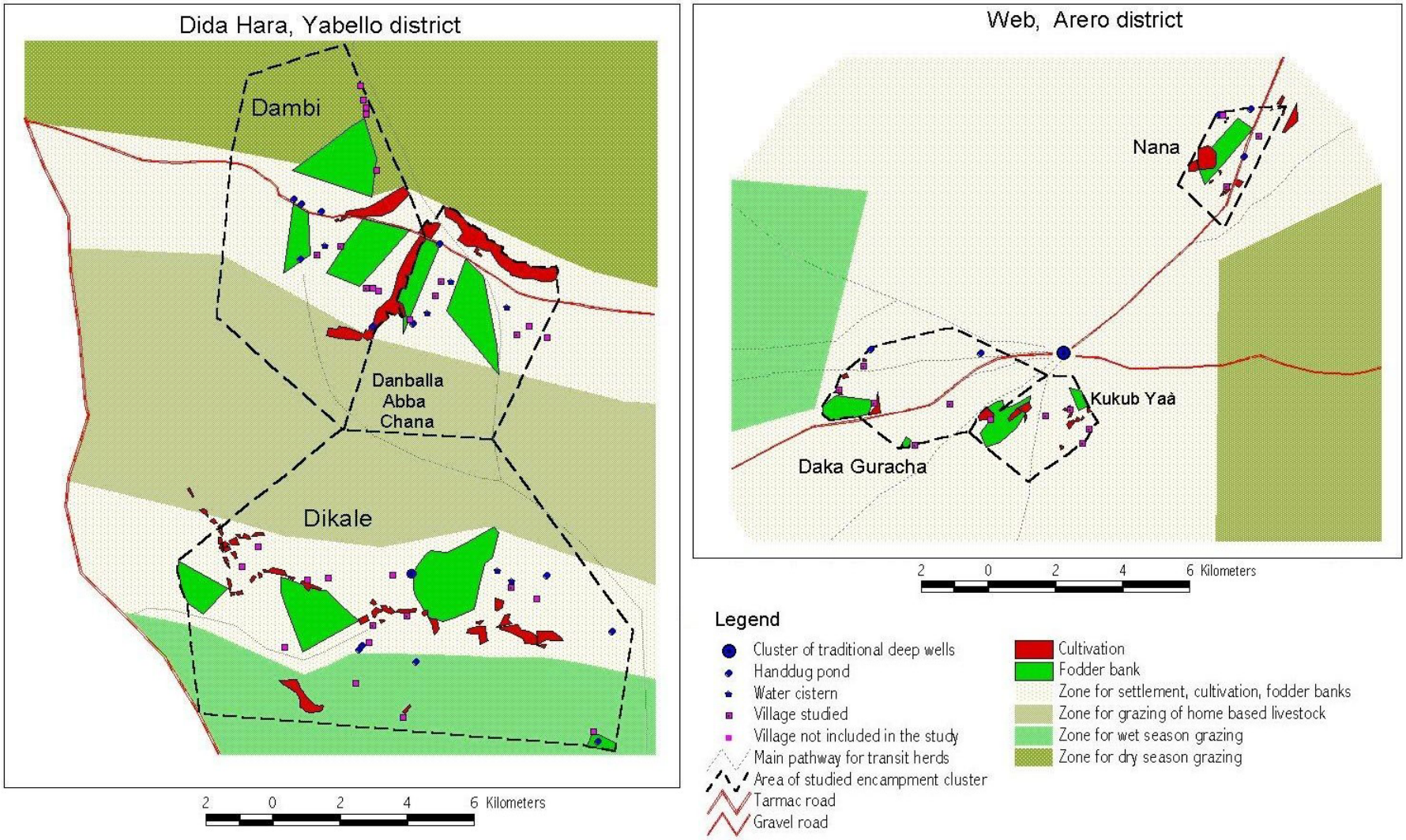
[53] The name Dida Hara means ‘plain grassland with temporary water sources’, symbolising a favourable rainy-season grazing area (Doyo Dulatscha, Borana elder from Dida Hara, pers. comm., 2001).

grass around the encampments was reserved for smaller calves (*mara qu'ee*), and every herder was expected to take his livestock for grazing in accordance with the "*orally fenced demarcations*" (Doyo Dulascha, Borana elder from Dida Hara, pers. comm., 2001). Additional forage-banks were reserved for weak and sick animals to use during periods of forage scarcity (*lafa seera yabiye*). These reserves were shared by several encampment clusters, and this helped to avoid fragmentation of the rangeland. Pastures within a day's walking distance of about 15 km were prohibited from any utilisation except grazing and walking (*mata tixaa).* Several pathways channelled the herds to the watering place (*kara oba)*. The pastures for rainy-season and dry-season grazing were found in the periphery to these central grazing areas, and they were kept open to move the satellite herds (*lafa gue'ssa*). Peripheral grazing areas towards other wells were used as last rescue areas during heavy dry-season (*lafa seera bonna*) and the more remote areas - such as Dida Hara - were used during the rainy-seasons (*lafa seera roba*).

Apart from efficient use of the available pasture and water resources, mobility of the herds also allowed an adequate recovery of the dry and rainy-season pastures. To allow a better valorisation of natural resources, particularly water and pasture, the Borana pastoralists stratified their cattle herds (A8 in ATable 1) in accordance with their physiological status, age, sex and walking ability (ATable 9) and assigned sources of water and pasture to these groups. Calves of both sexes younger than 5 months *(waatiye)* were kept on open grazing around the encampment and were supplemented with forage cut and carried to them. Lactating cows providing milk for the households (*looni haawichaa*), weak or sick animals and animals younger than two years *(yabiye)* dominated the grazing herds in locations like Web. After the onset of the first rains satellite herds were split progressively and moved further, to ensure sufficient water and pasture for the remaining herds in Web throughout the year. Predominantly dry cows (*looni gue'ssa*) and adult males were moved to more distant pastures like *Wayama, Gomoole, Malbe* or *Golboo*. In bigger herds, additionally groups of castrated males (*sanga*) were split and grazed separately. The castrated males were considered as precious animals, which also allow the exploitation of more distant pastures, deep into the *Wayama* area. The time and the number of animals that had to move to a new place were decided against the background of the relevant resource knowledge acquired by the range scouts (*aburro*) and from other available information sources. Moving the herds became generally more compulsory when livestock density was high. Owners of large herds were requested to keep their satellite herds away from the home-based pasture. The small ruminants were herded separately from cattle, in joint flocks from several households, mostly

near the encampments or in remote areas like *Golboo* around satellite camps.

The pastoralists' explanations (A1, A2, A3, A16 in ATable 1) revealed that after the development interventions water availability has lost its regulative function for the spatial organisation of mobility. The functional distinctions between the different ecological zones were said to be lost, so that the rangeland classification was no longer relevant. The former temporarily used grazing resources (*foora*) were increasingly adsorbed by permanent encampments. The owners of large mobile herds were the first who took the chance to establish encampments near to the new established water sources (compare chapter 4.3.1). They transferred the principle of *dongora sera* and arranged two lines of encampments in parallel direction to the gravel road from Arero to Yabello. The study encampment clusters Danballa Abba Chana and Dambi for example, are clustered along the first line near the road and Dikale along the second line 12 km south-east (Map 5). The former dry-season grazing areas experienced an increasing density of permanent encampments. Web has always been a focal point for permanent encampments at the eastern edge of the traditional dry-season centre *Dirre*. The GPS measurements attest, that the encampment cluster Nana was on proper position of the encampment line at 12 km distance to the wells, whereas Kukub Yaa and Daka Guracha occupied an area close to the wells which was formerly reserved for dry-season grazing only.



Map 5. Current land use categories of the three encampment clusters studied in Dida Hara and Web.

Source: Author, based on own GPS measurements.

According to the explanations of pastoralists from Dida Hara and Web (A1, A2, A3, A16 in ATable 1), the increasing grazing pressure threatens especially the areas close to the encampments (*warra*), formerly preserved for the herds with lactating cows. The grazing pressure was accelerated by new private forms of land use emerging within the encampment area, namely crop cultivated land (*oobruu*), forage-banks (*kallo*) and water cisterns with adjacent fenced-off pasture areas. They induced more exclusive rights to land and took off further resources from the communal grazing areas formerly for the lactating herds. The pastoralists were aware that the area for crop cultivation expanded preferably at bottom-lands of fertile alluvial soils, formerly the most valuable grazing resources. According to own observations, pastoralists in Dida Hara and Web practised opportunistic crop cultivation by installing their fields together in a block with a common demarcation of spiny *Acacia* branches, pooling labour in ad hoc assistance groups (*dabo*) and using the crop residues for grazing of those herds who shared the same fence. Pastoralists at both locations explained that the proportion of de facto cultivated area varies from year to year, depending on the resource endowment of the individual households. As Kamara *et al*. (2003, 2004) also reported, the practice has been casually abused, privatising pastures in the name of crop cultivation. The pastoralists further explained that formerly open grazing-reserves for calves and weak animals became protected by spiny tree branches and thereby they got the status of fenced-off forage-banks. In Dida Hara, water cisterns[54] have been established, but do not occur in Web. The introduction of water cisterns was connected with fencing-off the adjacent pasture as a grazing reserve for the users of the cistern Tache (2000a, 2000b) reported abuse by Borana pastoralists, selling water and appropriating nearby pastures.

According to the pastoralists in Dida Hara and in Web the increasing grazing pressure on the common pastures close to the encampments is caused by the reduction of the daily grazing radius for cattle (*mata tixaa*) from about 15 to 8 km, to avoid to enter the grazing orbit of the adjacent encampments. An increasing number of watering pathways (*kara oba*) intersects the remaining pastures. Additionally, the fenced demarcations like crop cultivation blocks, forage-banks and water cisterns become obstacles to the movements of the herds. Investigating changes in rangeland classification with the pastoralists further revealed that in

[54] The water cisterns were constructed with NGO support, initially to provide drinking water for home consumption. The communities were requested for contribution and appointment of management committees.

the late 1970s the communities in Dida Hara and in Web have tried to assign additional communal grazing reserves adjacent to their home-based grazing areas for preservation of sufficient dry and rainy-season forage (*mirti*). In Dida Hara, a string north of the road in direction to constructed water ponds was reserved for dry-season grazing (Map 5). A second string south-east of the encampment line with remaining temporary accessible pastures was for rainy-season grazing. In Web, a south-eastern string in direction to other well clusters was reserved for dry-season grazing. A second north-western string towards the same grazing area used by herds from Dida Hara was for rainy-season grazing. However, different reasons have led to the use of these reserves for permanent grazing: The Borana pastoralists established permanent encampments also in the dry-season reserves north of Dida Hara, as a means to prevent the further invasion of the neighbouring Gujji ethnical tribe. Permanent encampments expanded in the dry-season reserve south-east of Web, after the formal administration had implemented the water borehole and a new administrative PA. The rainy-season area between Dida Hara and Web becomes increasingly absorbed by permanent encampments due to the refusal of individual households to leave the area during dry-seasons.

The GPS measurements and in-depth analysis of current land use categories (A17 in ATable 1) at the home-based areas (*warra*) of Dida Hara and Web revealed differences in size between the locations (Table 5, Map 5). The total area of the home-based area is today about ten times bigger in Dida Hara district than in Web district. The total area cultivated extends in Dida Hara over large bottom-lands, whereas in Web such natural depressions are less pronounced and the fields are more dispersed. Also, the size of forage-banks in Dida Hara is about six times larger than in Web. However, the average proportion of crop cultivation and forage-banks does not differ between the two districts.

Table 5. Average land use categories (ha and %) in encampment clusters in Dida Hara and Web.

Land use category	-----Dida Hara-----		--------Web--------	
	[ha]	[%]	[ha]	[%]
Crop cultivation	863	4	138	5
Forage-bank	2,641	10	307	11
Common grazing	20,725	86	2,466	85
Total land	24,230	100	2,911	100

4.3.3.2 Indigenous institutions

The Venn diagrams (A14 in ATable 1) – cross-checked by key person interviews with elders (A2 in ATable 1) - revealed that traditionally, the decisions for the allocation of range and

water resources were enforced by a complex network of specialised institutional branches. The indigenous institutions were represented by experienced elders, recognised for their skills and good conduct (Figure 10a): Clan affiliated institutions provided the right of free access to water and pastures for every member of the Borana. Each well was under the trusteeship of a specific clan, and a manager was appointed for the daily administration of the well (*abba herrega*). The clans were also responsible for social security. A peaceful resolution of conflicts within and between clans was expected. In case of emergency special messengers (*jallaba*) and convenors (*abba quaee*) were appointed to conduct ad hoc meetings looking for solutions. The water management at the level of the clans was supported by institutions determined by locality. Special committees of elders (*jarsa madda*) were responsible to co-ordinate each well with the use of the adjacent pasture (*madda*). Additional elders' committees (*jarsa dheedaa*) co-ordinated the access of cattle to shared seasonal grazing areas (*dheedaa*). The responsibility for small-scale land use planning was conferred to committees of neighbourhoods (*jarsa reera*) and of camp clusters (*jarsa ardaa*). At *ardaa* meetings a special decision called *mura* was passed when the big cattle herds had to move during rainy-seasons to areas such as *Wayama* or *Gomoole*. Affairs at village-level were firstly directed to the head of the village (*abba olla*) and each household was represented by the head of the household (*abba warra*). Directives for good governance for the entire Borana society were reviewed by the *gumi Gaayo*, the legislative assembly, and supported by officials of the *gadda*, represented by the *abba gadda*. Special counsellors (*hayyu*) were mediators between these institutions. The traditional institutional set-up was perfectly suited to make use of the Borana pastoralists IK, and to manage the available natural resources sustainably. In the traditional system, the location of Web represented an area of several deep wells in a cluster (*madda*), with each single well belonging to a different clan and being managed by another *abba herrega*. Web was one of the sites for permanent encampments, and incorporated the locality-based institutions for land use planning at a smaller scale (*jarsa reera, jarsa ardaa, abba olla, abba warra*). The access to pastures surrounding the Web wells and potentially overlapping with the neighbouring well clusters of Higgo, Gaayo and Dhaas (Map 4) was under supervision of the *jarsa madda*. In contrast, the location of Dida Hara was exclusively a temporary grazing area without permanent encampments (*dheedaa*), and therefore controlled only indirectly. Among the users of Dida Hara, experienced elders were delegated for temporary consultations (*jarsa dheedaa)*. The clan affiliated and governance institutions integrated each member of the Borana in common principles of natural resource management, irrespective of the location.

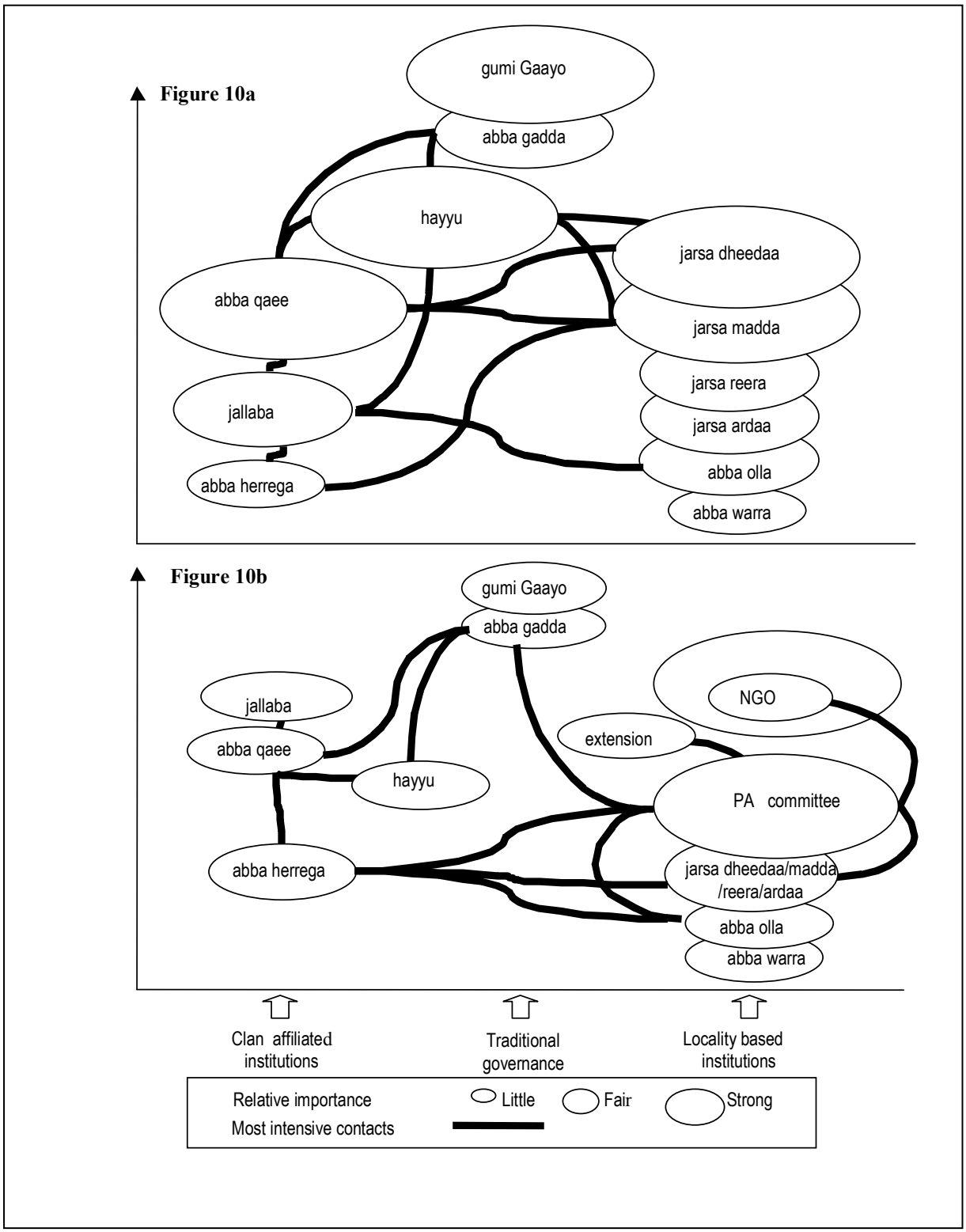


Figure 10. Venn diagram designed for pastoralists' common perception about most relevant institutions for natural resource management in Web and Dida Hara; 10a. Indigenous institutional set-up 30 years ago; 10b. Changed institutional set-up today.

The comparison of the Venn diagrams of the current and the past importance of pastoral institutions shows that the indigenous institutional networks by which the pastoralists governed the access to pasture and water resources have been seriously affected by the administrative changes (Figure 10b). Most destructive for the large-scale co-ordination of herd movements is the erosion of the administrative flexibility by the locality based institutions. The different committees responsible for larger scale land use planning, co-ordination of herd movements, and regulation of access to resources (*jars ardaa, jars reera, jars madda and jars dheedaa*) almost lost their function. The committees for regulating the access to shared grazing areas (*jars dheedaa*) were already hardly remembered by most of the respondents. Instead, immediate response-reactions between the head of the encampment cluster (*abba olla*) and the representatives of the formal administration (PA committee) predominate. The additional transfer of formal education and extension to the PAs further undermines the authority of the traditional institutions. The multiple cross-linkages of the institutions for land use planning to the institutions for social security (*jallaba and abba quaee*) are severely weakened and the fundamental mediation of the traditional governance body (*hayyu*) becomes rudimentary. As Oba (1998) has also mentioned, the pan-Borana assembly *gumi Gaayo* did not possess the authority to prevent the misappropriation of grazing land by pastoralists and non-pastoralists, and is therefore not fully operational. These trends were observed at both study sites, in Dida Hara and Web. The only difference was that in Dida Hara, the NGO activities were appreciated for their contributions to relief and rehabilitation, and therefore ranked as strong in importance. Whereas, the development efforts in Web were considered as critical, because they were dominated by the PAs and therefore they had little importance. The Venn diagrams further indicated the common perception that only those institutions concerned with the administration of water have sustained their full importance over the last thirty years. Controlled by the *abba herrega*, the deep wells in Web are still fully operative (Figure 10).

Interviews with water managers (*abba herega*) (A7 in ATable 1) revealed that essential principles of water management have been transferred to the newly constructed ponds in Dida Hara (Photo 3; Photo 4). Temporary directives determine the utilisation of different water sources such as the deep wells, machine dug ponds, smaller hand-dug ponds and watering cisterns near encampments (Figure 11): Basically, one is entitled for access to water by maintaining a relationship to the person who initially has established the water source (*konfi*). The right to water from wells is organised by clan-membership (*goosa*), whereas pond users are the adjacent inhabitants. However, the access to water is handled with flexibility, and

extra rights are accorded through social relationships and in emergency situations. The users of water, from wells as well as from ponds, join in assemblies for common co-ordination and control (*kora ela*)[55]. They decide upon supplementary restrictions: After rainfall, the open water sources are used and the wells are closed temporarily. With ongoing dry-season, the herds are successively shifted to more distant ponds, and traditional wells are re-opened to preserve the water near the encampments. According to the livestock's water needs, horses have always precedence, followed by cattle and small ruminants, and dromedaries drink at last. With progressing scarcity in water, the drinking frequency of cattle is gradually reduced to drinking once a day (*dhabsuu*), every two days (*limmaalimma*), and every three days (*sadeen*). A further restriction of daily watering is serving the herds of the holder of *konfi* first, afterwards those of the *abba herrega*, and finally other users according to their relationship to the holder of *konfi*. Under the direction of the *abba herrega*, three persons are appointed for supervising the proper operation of the water source (*abba guya*). They alternate every three days in responsibility. The access to water is linked with tasks of cleaning, maintenance and rehabilitation. Every user of water has to provide sufficient labour, not only to water his livestock but also for the maintenance of the water place (*obatu*). Evidence of good water management is that cattle should never enter the open water, but drink the water hauled into troughs made by clay or cement (*naaniga*). At ponds, cattle are restricted from entering the water by progressive shifting of spiny tree branches (*merri*), or, where lime soil allowed the construction of troughs, the water is also hauled into *naaniga.*

[55] *Kora ela* in its original terms refers to assemblies at deep wells, and was transferred to the assemblies at large ponds.

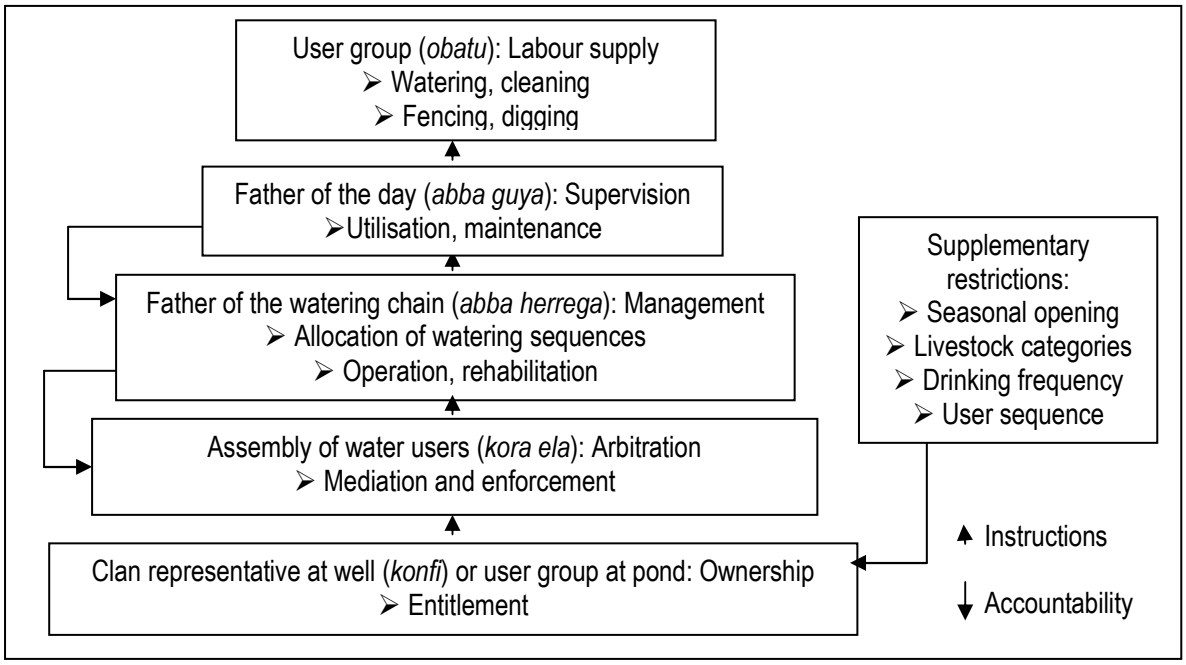


Figure 11. Principles of water management, designed for traditional deep wells in Web and new ponds in Dida Hara.

Photo 3. Water management at a traditional deep well in Web.

Photo 4. Co-ordinated access to water at a pond in Dida Hara.

4.3.3.3 Negotiation procedures

The discussions with elders and herders on changes in the Borana seasonal grazing system and erosion of indigenous institutions (A1, A2, A3, A14 in ATable 1) also provided insights on the role of negotiation procedures to co-ordinate the movements of herds in space and time. In the past, the co-ordination of large-scale herd movements between different user groups with overlapping claims for water and pastures was achieved by continuous negotiation procedures among the Borana pastoralists as well as with other ethnical groups. The institutional networking ensured a continuous transfer of information and enforcement of the agreements. The frequency of negotiations depended on the number of arising cases of conflicts of interest in order to allow a flexible adaptation to temporary constraints. Most problems were solved immediately at the local-level (*olla, ardaa, reera;* compare Figure 10). More complex issues were transferred to higher levels of spatial organisation (*madda, dheedaa*), or to the clan-level (*goosa*). For an efficient co-ordination special meetings were regularly conducted, such as the *kora dheedaa*, annual meetings to plan for the re-partitioning of the rainy-season pastures, or the *kora debanu*, the clan-based convocations after a drought to consult about the rehabilitation of deprived clan mates (*buusa gonofaa*), or the *gumi Gaayo*, largest assembly for revising rules and regulations every 8 years.

Pastoralists in Dida Hara and Web reported (A14, A16 in ATable 1) that the transfer of decision making power to the PA-level has restricted natural resource management to limited areas, irrespective of pasture condition or water availability. The knowledge of competent elders is no longer utilised. Disregard of the traditional authorities causes additional conflicts between generations and increases the disagreements within and between the communities. Heavy shortage of pasture and water due to drought, loss of grasslands and wells, and inter-ethnical conflicts periodically aggravate the trespassing of the directives for grazing and encampment. On the other side, the PA officials lack the knowledge and the capacity to make appropriate decision on rangeland management, and a lack of respect for the PA officials was also observed. Pastoralists at both locations explained that the absence of a clear role description for the traditional authorities and the formal PA administration weakens the enforcement of decisions for the controlled utilisation, the maintenance and rehabilitation of rangeland resources. A minority of wealthy herd owners can assure their access to pastures and water through corruption, less competitive users are excluded. The deteriorating negotiation procedures lead to the breakdown of information and communication structures, which formerly are necessary to cope with the high risk environment.

The procedures and the effectiveness of negotiations about the utilisation of the home-based rangeland resources varied according to the locations (A10, A14 in ATable 1). In Dida Hara, the lobby of powerful herdsmen was said to enforce the encampment in line (*dongora sera*) on the newly occupied grazing area, and the agreements for the home-based grazing areas have been successfully respected until now. Disputes about user claims for pasture and water within the grazing area of Dida Hara were solved by involvement of the formal administration at PA and woreda-level. The owners of large herds were known to defend the grazing area of Dida Hara to their satisfaction. However, on external pastures they were accused to trespass the agreements with neighbouring Borana pastoral communities by their financial power. In comparison, pastoralists in Web complained that the co-ordinated allocation of encampments in line (*dongora sera*) have been increasingly trespassed, after wars and droughts. The enforcement of grazing directives on external grazing reserves including *foora* sites seems more difficult, and pastoralists from Dida Hara and from Web have observed different forms of trespassing. The remaining rainy-season *foora* areas between Dida Hara and Web were contested since the last drought because scattered encampments have remained at their satellite camps for permanent grazing instead to leave it temporarily. In various cases access to rainy-season pastures was given to herders who paid illegally the formal administration. Compliance of privileged herders with the formal administration was also noticed for the access to the grazing areas belonging to a former ranch, which was in process to be handed over to the local community. Even within communities, disputes about entering the forage banks (*kallo*) without consent of the user group and casually against payment to single members of the *kallo* user group were reported and point to the dilemma of non-transparent decision making at the local-level.

4.3.3.4 Socio-economic equity

The definition of local wealth categories (A11 in ATable 1) - cross-checked by the socio-economic baseline survey at household-level (A12 in ATable 1) - showed that the heterogeneity in wealth has increased. Borana pastoralists reported that traditionally, the socio-economic status of a household was defined by the number of cattle at its disposal. Oral sources like the traditional Boran cattle songs or the elders' narratives suggested that ownership of many cattle was considered as an asset that was either achieved by personal expertise, but more probably it was a question of good fortune during droughts. When a herd successfully overcame a drought this was interpreted as a mercy and the owner had to pay his tribute to those who lost their livestock guiltlessly. Thus, 30 years ago, wealth had a more

temporary connotation and redistribution of wealth was institutionalised at clan-level (*buusa gonofaa*). This offered to every member of the Borana the chance to overcome heavy losses in livestock and it obliged those with many heads of livestock to assist destitute clan members.

Meanwhile, external interventions have induced socio-economic differentiation within and between the pastoral communities. There is evidence that the fragmentation of Dida Hara and Web grazing areas essentially contributed to the establishment of large herds and increased the disparity between different strata of wealth. In Dida Hara, the owners of large mobile herds were the first to occupy the grazing areas near to the newly constructed water ponds (compare chapter 4.3.1), used the advantage of easily watering their herds and moved out sporadically when water and pasture were insufficient. They ensured their economic position by investing in assets other than livestock, while more and more households were forced out of livestock production, driven by the shrinkage of the natural resource base, and reinforced by the recurrent droughts and unfavourable terms of trade[56]. In Web mainly the owners of smaller herds with lower watering requirements have remained. Here, the wealth-level was kept at a low level (Table 6). After the last drought all households in Web and most households in Dida Hara fall into the lowest wealth-level, but in Dida Hara 6% of households are still very wealthy.

Table 6. Frequency of households (%) classified by head of cattle before and after the drought in Dida Hara and Web.

Head of cattle	-----Before drought-----		-----After drought-----	
	Dida Hara	Web	Dida Hara	Web
	----------[%]----------			
< 50	56	78	91	100
50-99	23	16	2	0
100-149	8	6	1	0
> 150	13	0	6	0

Source: Socio-economic baseline survey (n = 182 in Dida Hara, n = 58 in Web) (A12 in ATable 1).

The drought had an aggravating effect on the discrepant distribution in wealth. Comparison of the average number of cattle per household for the traditional wealth classes showed that after the drought better-off households in Dida Hara owned over 37 times more cattle than the poor, and in Web all households were poor (Table 7). Before the drought the average herd

[56] Oba (1998) quotes GRM (1999) and Galgallo (1997) that during the 1991/92 drought prices for cattle declined by 90%, and the prices for grain increased by 150%.

size of better-off households has been in Dida Hara 11 times and in Web 5 times larger than that of the average poor households. These findings confirm that the livestock human^{-1} ratio has fallen below the minimum requirements of 3 TLU per African Adult Male Equivalent (AAME) for the majority of the Borana pastoralists (Sandford and Habtu, 2000).

Table 7. Mean herd size (heads of cattle) per traditional wealth categories before and after the drought in Dida Hara and Web.

Wealth categories	-------Dida Hara-------		---------Web--------	
	Before drought	After drought	Before drought	After drought
	----------[heads of cattle]----------			
≤50	26	9	25	11
51-100	64	78	67	n.f.
>100	289	333	117	n.f.
Average	89	28	37	11

Source: Socio-economic baseline survey (n = 182 in Dida Hara, n = 58 in Web) (A12 in ATable 1).
n.f. = not found.

The effect of drought on the distribution of wealth was confirmed by the communities' subjective perception of wealth categories (Table 8). Pastoralists in Dida Hara and in Web revised the wealth categories after the drought (A11 in ATable 1). They defined lower thresholds for wealth after the drought as the average herd size has been decimated to one third. The subjective thresholds for wealth classes were lower in Web as the cattle herds in Web were on average smaller.

Table 8. Definition of indigenous wealth categories (heads of cattle) before and after the drought in Dida Hara and Web.

Wealth categories	-------Dida Hara-------		---------Web--------	
	Before drought	After drought	Before drought	After drought
	----------[heads of cattle]----------			
Poor	0-50	0-20	0-50	0-10
Middle class	51-100	21-50	51-100	11-20
Better-off	>100	>50	>100	>20

The decline in wealth along with a higher differentiation between the locations becomes more obvious when relating the share of cattle to the share of households in the different wealth groups (Table 6, Table 9). Before the drought, the better-off households in Dida Hara made up 21% of the total households but owned 67% of the cattle. This discrepancy is intensified after the drought, as only 7% of the households still own 65% of the cattle. In Web before the drought, most of the cattle were owned by poor households, and after the drought all cattle were in hands of the poor.

Table 9. Distribution of cattle (%) per traditional wealth categories before and after the drought in Dida Hara and Web.

Wealth categories	-------Dida Hara-------		---------Web--------	
	Before drought	After drought	Before drought	After drought
	----------[%]----------			
≤50	17	27	53	100
51-100	16	8	29	n.f.
>100	67	65	18	n.f.

Source: Socio-economic baseline survey (n = 182 in Dida Hara, n = 58 in Web) (A12 in ATable 1). n.f. = not found.

Inducing socio-economic differentiation in wealth, the interventions had negative effects on the pastoralists' potential to co-operate. The pastoralists at both locations complained that differentiation in wealth, along with differing interests and labour availability led to different activities making common agreements more and more difficult and is to the disadvantage of joint herding management. In the words of Boru Nura, a Borana elder from Web (pers. comm., 2001), "*...formerly group herding was successfully applied to the cattle. Herders were experts and cattle did not die easily. Today, group herding is avoided as it causes problems among the people. People have developed different interests. Some remain herder and others engage in crop cultivation, trading, gold-mining or send their children to school. Such people don't pay attention for herding. They hand over their animals to young girls, boys and old people. Therefore, those people with sufficient manpower want to herd individually, to guarantee proper care for their animals.*"

4.3.4 Consequences for range ecology and for livestock production

4.3.4.1 Rangeland conditions

Scarcity of pasture areas and rangeland degradation are the result of many factors, but external interference has played an aggravating role in Dida Hara and in Web (compare chapter 4.3.1). The pastoralists in Dida Hara and Web observed a rapid degradation of the former rainy-season pastures and of the former dry-season grazing area, respectively (A3 in ATable 1). These observations were confirmed by an ecological evaluation at the selected research locations (Dalle in Homann *et al*., 2004). Dalle's results revealed that the overall conditions of the Borana rangelands were only fair and that the trend was further downward. This was reflected by the low scores for the botanical composition in the study area. Dalle found the rangelands to be poor in grass bio-diversity and in forage production, indicated by a

very low frequency and density of highly palatable forage grass species. The most frequent grasses found in the studied areas were intermediate in forage value, such as *Chrysopogon aucheri (Alaloo)*, *Sporobolus festivus* and *Eragrostis heteromera* (*Saamphillee*). The excellent grass species such as *Cenchrus ciliaris* (*Mata guddeessaa*), *Panicum repens* (*Hiddoo*), *Digitaria macroblephara* (*Hiddoo*), *Digitaria naghellensis* (*Ilmoogorii*) and *Dactyloctenium aegyptium* (*Ardaa*) were much less frequent. The range condition assessment was in agreement with the preference ranking of the pastoralists and showed the highly palatable grasses contributing 17% to the aboveground bio-mass, intermediate grasses 56%, and least desirable grasses 21%, the remainders were sedges and forbs. Dalle further investigated the differences in the functional grazing categories in Dida Hara and Web, with different impact of external interference and different utilisation in the traditional management system. His results have shown that - despite heavy interference through water development - the overall rangeland conditions were still better at the former rainy-season area of Dida Hara than at the former dry-season area Web. The total above-ground bio-mass production was higher in Dida Hara (702 $\pm$ 431 kg DM ha^{-1}) than in Web (443 $\pm$ 391 kg DM ha^{-1}), and the *foora* produced more bio-mass than Web *warra,* but less than Dida Hara *warra*. Bio-mass production in similar semi-arid ecosystems was reported much higher, with a grass primary production of 800 kg DM ha^{-1} considered as poor, 1,400 kg DM ha^{-1} as moderate, and 3,000 kg DM ha^{-1} as good (Weber and Jeltsch, 2000). According to these values the current herbaceous yield in the area was very low and was lowest in Web.

Dalle's assessment of the woody species encroachment indicated that the Borana rangeland system has crossed the boundary between grassland and shrub-invaded grassland and thus was in encroached condition. Woody species encroachment as an indicator for rangeland degradation has increased from $\leq$ 40% plant cover in the late 1980ies (Coppock, 1994) and affected about 52% of the study area during the research phase, with a mean woody plant density of 4,252 plants ha^{-1}. The abundance of woody plants was negatively correlated with herbaceous bio-mass production. The area of Web (65%) was more encroached than Dida Hara (50%) and the state of the *foora* was between. The most dominating woody species were in Dida Hara *Acacia drepanolobium* (*Fuleensa*), *Commiphora africana* (*Hammeessa*), *Acacia seyal* (*Waaccuu*), *Acacia brevispica* (*Hammareessa*) and *Acacia etabaica* (*Alqabeessa*), differently from those found in Web like *Acacia mellifera* (*Saphansa gurraacha*)*, Acacia reficiens* (*Sigirsoo*)*, Acacia oerfota* (*Waangaa*) and *Acacia senegal (Hidhaadhoo* or *Saphansa diimaa*). Additionally, an average of 16% of the rangeland was bare-ground. In Dida Hara, the bareground was similar for the *warra* and *kalo* areas *(*10%). In Web, the bare-ground was

comparatively high for the *warra* area (30%), but low for the *kalo* area (4%).

Dalle's results from discussions and interviews with Borana pastoralists reconfirmed that the pastoralists observed a declining quality of grazing resources and a reduced herbaceous yield in the area, in terms of density and frequency. They specified the beginning of the degradation 30 years ago. They differentiated indicators for over-grazing as lack of grass (*barbadaa*) and for degradation as bare ground not producing any grass for several years (*adaala*). They evaluated the process of the deteriorating rangeland conditions as a decrease in amount of available forage grasses, diversity of forage grasses, milk production and conception rates. The pastoralists summarised the main reasons for the deteriorating of the rangelands as the shrinkage of the accessible pastures, aggravated by the woody species encroachment, the shortage of rainfall and the high population density. Expansion of crop cultivation and restricted access due to tribal conflicts were also seen as contributing to the shortage of forage. Woody species encroachment was ranked as the biggest ecological problem. It was interpreted as the consequence of the ban on rangeland burning persecuted by severe punishments, of the obstruction from cultural practices, and of increasingly unreliable rainfall. Besides reducing the availability of forage resources and restricting their accessibility, woody species were blamed for inducing serious danger by harmful wildlife such as hyena. The ecological degradation of the Borana rangelands directly affects livestock production and presents a high risk for food security for the region.

4.3.4.2 Breeding preferences and livestock performance

The high quality Ethiopian Boran cattle were a result of the breeding and selection strategies of the Borana pastoralists. The study of current genotypes and breeding preferences in Dida Hara and Web (A8 in ATable 1) revealed two distinct types of the Ethiopian Boran cattle in the sample herds: the traditional large-framed *qorti*, considered here as the true type of the Ethiopian Boran cattle, and the smaller *ayuna*[57]. The pastoralists at both locations in line with scientific descriptions characterised the phenotype of *qorti,* as being of tall height with comparatively long legs, broad back, long neck, pending dewlap, short horns, small hump and a short tail. The original and the most preferred coat colour for Boran cattle were light grey

[57] The Borana pastoralists differentiated the breed types for cattle, small ruminants and dromedaries in *qorti* and *ayuna* (compare Reda, 2001). Adams and Kaufmann (2003) describe similar findings on pastoralists' selection strategies for dromedaries in northern Kenya.

for the body and dark grey around the dewlap. *Qorti* was known for high fertility, good growth and its milk producing capacity under range conditions. Under favourable conditions of the rangelands the pastoralists preferred the large-framed *qorti* type. However, compared to the *ayuna*, the *qorti* was observed to show lower tolerance to drought and ticks and poor adaptation to scarcity of forage resources.

In contrast, the *ayuna* type was described as less in height, smaller in body size, but more adapted to degraded rangeland conditions. It was judged as generally poorer than the *qorti* in fertility rate, beef and milk production. The *ayuna* showed a greater variety of colours including black. Pastoralists disliked black animals, because they assumed black cattle to have the lower productivity of the *ayunas*. The pastoralists also named a third category of animals that exhibited features that were said to be intermediate between those of the *qorti* and *ayuna*.

Indeed, the body weight measurements (A18 in ATable 1) confirmed a significant difference between adult *ayuna* and *qorti* cattle ($p<0.01$), with the *qorti* being 41 and51 kg heavier than the *ayuna* during the dry and rainy-season, respectively (Table 10). The average body weights of adult female *qorti* and *ayuna* were significantly different during both seasons ($p<0.01$) with female *qorti* weighing about 39 and 43 kg more than the *ayuna*. This was also true for the males ($p<0.05$), with male *qorti* being heavier by 69 and 104 kg than *ayuna* during the dry-season and the rainy-season, respectively. However, the intermediate type showed weights close to the *ayuna*.

Table 10. Average body weights (kg) of adult Boran cattle from sample traditional herds by phenotype and sex measured during the dry and rainy-seasons in Dida Hara and Web, 2001/02.

Type	-------Dry-season--------			--------Rainy-season------		
	Sample n	Mean -------[kg]--------	se	Sample n	Mean -------[kg]--------	se
			Overall			
Qorti	112	277.7[a]	6.1	148	317.0[a]	5.2
Intermediate	76	235.3[ab]	4.0	50	282.0[ab]	7.0
Ayuna	86	237.0[b]	6.4	71	265.7[b]	4.5
Total	274	253.2	3.6	269	296.9	3.6
			Females			
Qorti	95	270.2[a]	6.1	127	308.0[a]	4.9
Intermediate	66	231.0[ab]	3.1	44	270.2[ab]	5.0
Ayuna	61	231.4[b]	5.7	62	265.5[b]	4.5
Total	222	247.9	3.4	233	289.5	3.3
			Males			
Qorti	17	319.1[a]	19.0	21	371.2[a]	17.6
Intermediate	10	263.5[ab]	21.5	6	368.0[ab]	26.3
Ayuna	25	250.4[b]	16.9	9	267.4[b]	19.0
Total	52	275.4	11.7	36	344.8	14.0

[a,b]Means in columns followed by different subscripts are significantly different at $p<0.01$.

According to the pastoralists the two Boran cattle types have different geographical origins and consequently their typical habitats also differed. *Qorti* were said to have originated from the plains in the grazing lands of the eastern part of Borana rangelands; they are the true indigenous type. The *ayuna* type was said to originate from gradual introgression of cattle genetic material from the highlands into the herds in the north of the rangelands. Dida Hara was considered to be more appropriate for the *ayuna* type but Web was still judged as suitable for *qorti*. Indeed, the distribution of the cattle types in Dida Hara was significantly different from that in Web (χ^2-value = 28.3, $p<0.01$). The *qorti* showed a higher frequency of occurrence in Web than in Dida Hara, whereas in Dida Hara, the proportion of the intermediate animals was about four times higher than in Web (Table 11). The average body weights of the different cattle types were not significantly different between Web and Dida Hara confirming the distinctness of the sub-types in both sites. In total already 55.6% and 43.1 % of the adult sample cattle in Dida Hara and Web were of either *ayuna* or intermediate type.

Table 11. Frequency of occurrence (%) and average body weights (kg) of adult Boran cattle measured in Dida Hara and Web 2001/02.

	----------Dida Hara----------				----------Web----------			
	Proportion	Sample	--Body weight--		Proportion	Sample	--Body weight--	
Type			Mean	se			Mean	se
	[%]	n	-------[kg]------		[%]	n	-------[kg]------	
Qorti	44.4	173	297.0[a]	4.9	56.9	87	306.2[a]	7.5
Intermediate	29.2	114	251.4[a]	4.4	7.8	12	276.3[a]	12.9
Ayuna	26.4	103	244.5[a]	5.1	35.3	54	260.5[a]	7.2
Total	100.0	390	269.7	3.1	100.0	153	287.7	5.3

[a,b]Means in rows followed by different subscripts are significantly different at $p<0.05$.

The pastoralists in Dida Hara and in Web feared (A6, A12 in ATable 1) that the *qorti* was in danger of gradually disappearing from the Borana rangelands. At both locations pastoralists argued (A16 in ATable 1) that the rapid decline of pasture availability and the increasing recurrence of droughts were the main causes for the genetic erosion of cattle. The large frame Boran cattle were considered not competitive when the grazing resources were scarce. The pastoralists responded by selecting for the *ayuna* type with lower demands on forage and by increasing the adoption of small ruminants and dromedaries (compare chapter 5.3.2). In Dida Hara due to the rapid decline of pasture availability only a minority of wealthy herd-owners could afford to procure the *qorti* bulls either from the market or from the government-owned Boran cattle breeding ranch. The majority of the households maintained only a small proportion of the *qorti* and as in Web the level of performance was low.

The pastoralists in Dida Hara and in Web (A3, A10 in ATable 1) also observed a change within the cattle herd structure, namely the disappearance of satellite herds of castrated males (*sanga).* At both locations the castrated males were considered as a precious reserve which allowed the exploitation of more distant pastures, deep into the *Wayama* area. They were appreciated for high weight gains on quality pastures, during a drought they revealed as more resistant than cows and after a drought they were sold in exchange for heifers and thereby accelerated the rebuilding of the herds. Castrated males, formerly a common asset, have nowadays become a privilege of about ten wealthy Borana families. Most households had to sell their castrated males to buy food (Borbor Bule, Borana elder from Dubluq, pers. comm., 2001).

The current performance of livestock in Borana rangelands was investigated by discussions with pastoralists and information obtained from progeny history (A1, A3, A9, A10 in ATable 1). A straight comparison with the situation 30 years ago was not possible as no comparable data on livestock performance under field conditions in Borana rangelands were available. To verify pastoralists' reports and perception, the own data collected from progeny history were

compared to other authors' data for similar production conditions. The pastoralists complained about a reduced reproductive performance of all livestock species, caused by the recurrent droughts as well as by the shrinkage of available grazing resources. Indicators for low reproduction were said to be the low milk yield and a delayed conception. The results from the progeny history in comparison with other authors (ATable 10;

ATable 11) show that the current amount of milk from cattle (1 l day^{-1}) and dromedaries (2 l day^{-1}) was low (ATable 12). Goats' milk was primarily used for the offspring, and only occasionally fed to children. The average lactation length of cattle (10 months), dromedaries (13 months) was in the typical range of pastoral production (ATable 13). Dromedaries were advantageous in milk production, with a higher milk yield, a longer lactation period and more reliable productivity and survival during droughts.

The progeny history further revealed that the age at first parturition and the parturition interval was relatively high for cattle (55 and 19 months respectively), but normal for goats and dromedaries, which are kept under pastoral conditions (ATable 14; ATable 15). Precarious was the predominance of relatively young breeding females, which confirmed the heavy impact of drought on the populations (ATable 16). Up to 9 parturitions per female were reported for cattle and small ruminants and up to 6 for dromedaries, but 86% of the cattle, 79% of the goats and 77% of the dromedaries had only 3 parturitions or less (ATable 17; ATable 18). The younger cattle and dromedaries showed a 5 and 3 months' longer mean calving interval than the mature breeding females.

According to the pastoralists' information, the most important cause for leaving the herd was death, indicating the high loss of livestock resources to the pastoral systems, especially for dromedaries (ATable 19). The share of sales was lower, and similar for cattle and goats. Transfer-out through slaughtering, gift, loss theft was less important. The mortality rate of the offspring was mainly due to the drought-disease-complex (ATable 20). Pastoralists differentiated drought as the major cause for death of cattle (64%) and goats (53%), whereas disease was seen as the major cause for death of dromedaries (69%). In line with the high susceptibility for diseases, dromedaries showed a high rate of abortion (9%). About 19% of female dromedaries had experienced an abortion in their life (ATable 21). Predators were seen as a frequent problem for goats (17%), and were strongly associated to the woody species encroachment.

4.4 DISCUSSION

4.4.1 Data characteristics and interpretation

This in-depth study analysed the current organisation of natural resource management in comparison with the situation thirty years ago with emphasis on the impact of external interventions on IK based strategies for range and water utilisation. It complements the broader socio-economic study on the causes and nature of land use change of Kamara (2001). The historical perspective was seen crucial to explain the causes and the complexity of changes, and the adaptive capacity of pastoral systems (compare Abel and Langston, 2002). However, for many aspects of Borana rangeland and water utilisation no comparative quantitative information was available. A mix of methods, namely GIS based land use mapping, semi-structured interviews, group meetings using participatory techniques and stakeholder workshops at local, regional and national-level was applied to generate the necessary information. The necessity to draw on soft data and narratives leads to less precise results and may invite criticism but this imperfection cannot be avoided when describing the effects of external influences on pastoral management or changes in internal decision making processes. Triangulation[58] of methods, which was recommended by Bayer and Waters-Bayer (2000) for these situations, was used to minimise bias in the observations. The multi-stakeholder workshops at the end of the research phase were seen as a very important component of the process and were used to review the main findings of the studies with knowledgeable key persons and pastoralists' representatives.

The selected study locations – Dida Hara and Web – confirmed a difference in the degree of external interference and in the functionality in the traditional management system before the development interventions took place. Their comparison proved helpful to understand the changed preconditions for pastoral systems in the Borana rangelands and it elucidates the process from IK-based consultative range management at large-scale to a fragmentation of

[58] Triangulation of methods is defined by Bayer and Waters Bayer (2000:415): *"In order to reduce bias, the same issue should be studied from different angles (triangulation), using a variety of information gathering techniques (e.g. case studies, observations, key-informant interviews, focus-group discussions, topical quantitative surveys), a variety of units of observation (individuals,*

rangelands and distinct land use scenarios.

The historical comparison of the current land use scenarios in Dida Hara and Web with Borana pastoralists' range management strategies before the interventions started 30 years ago, revealed the changes in the utilisation of formerly interdependent grazing areas. After water became openly available in Dida Hara, the regular movements between dry-season pastures in Web and rainy-season pastures in Dida Hara have been given up. The opening of permanent grazing in the former rainy-season pastures of Dida Hara has withdrawn the access to the rainy-season pastures in Dida Hara for the temporary evacuation of herds out of Web dry-season pastures. Under current conditions the necessity to move out of Web was driven by the high inflow of external herds in times of water scarcity and heavy rangeland degradation near the wells. Dida Hara still had more forage available, though woody species encroachment has expanded rapidly in the formerly plain grasslands (compare Werner, 2003; Dalle, 2004). For the majority of the households mobility has taken the character of an emergency driven tactic. Thus, the water development in Dida Hara has destroyed the indigenous differentiation in functional rangeland categories, and thereby the temporal and spatial variations in the use of pasture and water resources[59]. Scarcity of water has traditionally been the key for restricted encampments and the allocation of grazing resources. The traditional regulations for establishing permanent encampments (*dongora seera*) were no longer enforced, uncontrolled encampments spread and permanent grazing encroached into the evacuation areas of the satellite herds.

The presented data on herd mobility, stocking densities, and human population densities have to be understood in relative terms as they are based on estimates from the pastoralists. The data on animal production were collected by progeny history, which has already been used successfully in pastoralists' herds (Kaufman, 1999). Live-weights were estimated based on measurements of girth circumference and applied to the local classification of this cattle species. However, detailed information about herd structures (percentage milking cows, heifers, bulls, castrated males, calves) or stocking densities per different functional grazing categories (*warra, foora, kallo*) were beyond the capacity of this study.

Despite the 'soft' nature of some of the underlying data strong evidence is provided to accept

households, communities) and a variety of disciplines in the research team."

[59] Similar negative effects were described by Thébaud *et al.* (1995) for the western Sahel.

the hypothesis that external interference in the Borana rangelands ignoring pastoralists' IK destroys the basic preconditions of the applicability of IK-based range management strategies. The results show that the external interference in line with the effect of droughts and population growth disturbs IK-based range management strategies in the Borana rangelands. Non-appropriate water development and governmental interference with pastoralists' management institutions was reflected in a reduced mobility as well as in a reduced variability in stocking densities, and was more pronounced in Dida Hara, where the artificial water ponds were established. Moreover, the underlying principles and structures of the range management system have been negatively affected: the functionality of land use classification and the related utilisation patterns have been severely disturbed; the indigenous institutional networks and negotiation procedures have been weakened restricting the consultative regulation of access to the natural resources at the larger scale; the greater socio-economic heterogeneity in Dida Hara and differences between Dida Hara and Web hinder co-operation in range management at the smaller scale. Under the conditions of reduced mobility and erosion of important institutional structures the generation and use of IK-based range management becomes increasingly difficult. External and internal disturbances have also resulted in alarming rangeland degradation within only 30 years, and accelerated the shrinkage of the available rangeland resources. The deteriorating rangeland conditions increasingly force the pastoralists to select for the smaller *ayuna*, which have lower demands for forage than the typical *qorti.* This also contributes to the decreasing livestock productivity.

4.4.2 Impact of development interference in Dida Hara and Web

Uncontrolled grazing patterns are interpreted as the result of destroyed customary property regimes, with socio-economic and ecological effects on the grazing areas (Kirk, 1999). Pastoralists in Dida Hara showed a greater readiness to abandon mobility. The socio-economic heterogeneity within the communities was high, and the diverging interests impinged negatively on the communities' potential to co-operate. Scarcity of water became a major problem during the drought, and the herds had to walk long distances to the remaining ponds or to deep wells. As confirmed by ODPPB (2000), Dida Hara suffered the highest losses of cattle in the Borana rangelands. After the drought, only the owners of large herds could afford regular movements by maintaining a secondary encampment in remote areas. The majority of smaller herd owners suspended mobility and reduced joint herding. Whereas, in Web it was observed that mobility was still pronounced. The herds were generally smaller and the households co-operated more in herding. During the drought, the herds had access to

the well water, but had to travel long distances for grazing. The scarce forage resources in Web and lack of alternative grazing areas forced the herders to roam on the nearby pastures also during the rainy-season, in order to exploit the forage before outsiders might arrive. The study results add to the findings of Kamara *et al.* (2003, 2004) that local communities adopt different development pathways in response to natural, socio-economic and political forces.

The drought (1999/01) has intensified the socio-economic heterogeneity between Dida Hara and Web as well as within Dida Hara. In Dida Hara the crash of the cattle populations aggravated the heterogeneity in wealth among the pastoral households. The minority of wealthy herd owners assured their possessions and reinvested in restocking after the drought. Whereas, the results showed that in Web all households became poor. The drought has reduced the cattle pressure on the pastures, and consequently most of the pastoralists have reduced herd mobility. The decrease in communal herding by the owners of smaller herds in Dida Hara has reduced their capacity to respond to the highly risk prone natural environment. These results support the thesis of McCarthy (1998) that poorly designed development interventions can rapidly induce socio-economic differentiation, being accelerated by the impact of droughts. In pastoral systems as the Borana one, an increasing heterogeneity in wealth implies divergent interests in production and counteracts the community's capacity to co-operate (compare Kamara *et al*., 2003, 2004). The question then is, in how far the different conditions in locations such as Dida Hara and Web restrict the capacity to revitalise IK-based range management in the Borana rangelands.

The land use assessments revealed structural differences between the locations. Dida Hara and Web differed in the total size of land use units and encampment agglomerations as well as in stocking densities, although the average human population densities were similar. The total land and the human population in Dida Hara were a multiple of those in Web. Accounting for the results of Kamara (2001), that bigger user units make co-operative behaviour more difficult, the findings indicate more structural constraints for an IK-based range management in Dida Hara. However, the average stocking density was in Web much higher than in Dida Hara, due to the high invasion of external herds seeking for water. The high stocking densities in Web were thus caused by the functional role as a former dry-season grazing area. These findings challenge another statement of Kamara *et al*. (2004) that low stocking densities foster co-operation and hint at the importance to consider indigenous land use functions.

When comparing the land use categories and the population densities among the selected encampment clusters within Dida Hara and Web, this revealed uneven distributions (ATable 4;

ATable 6). In Web, the highest human population density was at the periphery (Nana), where highly fertile alluvial soils and naturally open water puddles prevailed during the rainy-season. The lowest human population density was in an area closer to the centre and comparatively large in size, but of lower grazing quality (Daka Guracha). In Dida Hara, the human population density declined from the central area close to the tarmac road (Danballa Abba Chana) to the periphery (Dida Hara). The differences among the encampment clusters are interpreted as reflecting the local heterogeneity of the landscape, involving different pasture productivity and favouring different population densities.

In comparison, the estimated values for livestock stocking densities (ATable 5) were extremely high at the central encampment cluster in Web (Kukub Yaa) due to the inflow of external herds[60] during dry-seasons (peaks of 819 and 162 TLU km^{-2} during and after the drought, compared to the average stocking density of 173 and 70 TLU km^{-2} during and after the drought). The stocking densities in Dida Hara were comparatively low and less variable in space and time (on average 36 and 15 TLU km^{-2} during and after the drought). The average stocking densities for both regions (105 and 43 TLU km^{-2} during and after the drought) were much higher than the stocking densities between 12 and 14 TLU km^{-2} measured by Cossins and Upton (1987a, 1987b) during the 1980s. The stocking density after the drought was still above the potential stocking density for years of average rainfall (24 TLU km^{-2} calculated by Cossins and Upton, 1987a, 1987b).

The pastoralists' self-evaluation of the institutional networks highlighted the role of indigenous authorities in natural resource management and the impact of the formal administration in Dida Hara and Web. At both locations the erosion of institutional networks caused by the imposition of new administrative structures (PA) has destroyed the flexible rangeland management based on IK. The formal administration was implemented with the intention to extract pastoral resources for the development of the national economy. Emphasis was on public security, including government control and oppression of opposition, but little consideration was given to rangeland management (Helland, 2001). The PA*s* were linked to Borana pastoralists' territorial organisation of rangelands in relation to permanent water (*madda*). This undermined the pastoral administrative flexibility, which was typically based

[60] These herds come from different directions for temporary water utilisation; they belong to Borana clan mates and get access to the water although the herd owners are not residents of Web.

on the delegation of authority to responsible elders. Important indigenous institutions have lost their functionality. Today, the Borana elders' committees are no longer able to apply their knowledge in rangeland management and conflicts between and within the communities increase. More trespassing of regulations occurs, the maintenance and rehabilitation of rangeland resources is weakened, and the structures for decision making and IK generation further vanish. In contrast, the transfer of the indigenous water management to the newly constructed ponds demonstrated the capability of pastoralists' institutions, which have not been the objective of external interference. Together, these findings give strong evidence, that pastoralists can manage complex and heterogeneous grazing systems; but they fail, if hindered in maintaining community-based mechanisms for co-ordination and control. The Borana case study illustrates that over-exploitation of natural resources in an formerly exceptional efficient pastoral natural resource management system is a result of the 'creation of open access situations' and a key challenge for any attempt in pastoral development (Lane and Morehead, 1995; Kirk, 1999).

Furthermore, the procedures of negotiations among the Borana pastoralists themselves and between different ethnical groups are threatened by an intensified competition for rangeland resources, diverging interests upon the resources, and a growing number of households in poverty. Various factors contributed to the growing number of people who competed for the smaller resource base. Pastoralists blamed the federal government for the deprivation of important rangeland and wells (A16 in ATable 1; compare ABox 5). It is confirmed that the establishment of regional borders has transformed sporadic conflicts over resources into ongoing inter-ethnical warfare about territories (Gebre Mariam and Kassa, 2001). Lack of conflict management between Borana and Somali pastoralists has led to an under-utilisation of pasture resources in the contested areas. In addition, the extension services favoured the crop cultivation in valuable grazing areas. This has resulted in an expansion of crop cultivation around Dida Hara and a beginning of crop cultivation around Web (compare Werner, 2003). The ban on burning and the establishment of private commercial ranches exacerbated the disruption of the Borana traditional pastoral resource system.

The alarming growth of human population put further pressure on the natural resources, and has effectively reduced the per capita availability of these resources at both sites. Helland (1982, 1996, 2000) comprehensively described how the limited water capacity of the wells was formerly mediated into a density dependent population control. The limited water restricted the number of animals and implied a ceiling on the number of people. Households

without sufficient resources to compete for active participation in the water provision would have been expelled into poverty or client-ship. Supporting Helland (2000), the current exploitation rate of Borana rangelands has been heavily increased and this essentially contributes to the drought vulnerability of the entire Borana pastoral system. Desta (1999) reported that the average cattle per human ratio have declined from 4.1 to 2.3 TLU per person within only 15 years. Today, the self-determination of the Borana pastoral society is weakened, and it obviously increases their dependence on external support (Sandford and Habtu, 2000; Helland, 2001).

At both locations pastoralists complained about low herd productivity especially for cattle and dromedaries. As shown by Cossins and Upton (1988) and Coppock (1994) low milk production and a young age structure of female cattle are results of the relative impact of drought on the female cattle populations. Additionally, poor households have to extract the animals more intensively, and thereby increase the mortality rates (compare Scoones, 1996; Sieff, 1999).

4.4.3 Major constraints for indigenous knowledge-based range management

A controversy persists about how to deal with the complexity of poverty and degradation, although extensive research has been invested in the Borana rangelands (Coppock, 1994). It is acknowledged that development interventions which aimed at improved food security have essentially caused that the rangelands are used to capacity but did not empower the pastoralists to manage the natural resources sustainably. The effects of development programmes such as relief, restocking and veterinarian service stabilised the livestock and the human population. However, they reduced the pressure to sell or consume animals, and released claims to wealthy herd owners to redistribute livestock to destitute clan mates. Assuming that "*...sustainable pastoralism in the African drylands is only possible under the conditions of moderate to low population density*", Helland (2000:26) accuses interventions assisting a return to pastoralism as self defeating. Sandford and Habtu (2000) warned that too many people are trying to make a living from livestock of reduced rangeland with lowered productivity, which will inevitably result in an unsustainable over-exploitation of the remaining resources. Thus, facilitating households to move out of pastoralism is a necessary precondition when to make use of pastoralists' IK for a more controlled utilisation of the remaining rangelands.

Insufficient economic capacities of the Borana pastoralists pose a major constraint on the

applicability of IK-based range management. Traditionally, households above a certain herd size were requested to move parts of their herds out of the grazing area for the lactating cows. Provided that the permanent encampment was supplied with sufficient food, extra labour was pooled with other households, to join the mobile herds. Today, the majority of the Borana pastoralists have lost most of their livestock assets. Ndikumana *et al*. (2000) judged the cattle mortality in Southern Ethiopia during the 1995-97-drought with 78% as by far the higher than in other countries at the Horn of Africa. Borana pastoralists have tried to overcome their economically disastrous situation by different responses. In most cases, pastoralists have adopted crop cultivation, to prevent the sale of livestock and to recover from poverty. The expansion of small-scale crop cultivation into grazing areas was highly criticised by the pastoralists, but was considered as one of the few means to improve food security. The pastoralists were aware that crop cultivation adsorbed most valuable grazing resources and diverted labour from livestock production, while facing a high risk of crop failure or unsatisfactory harvests. Sandford and Habtu (2000) stressed that for Borana pastoralists, options for alternative income generation were few, due to the lack of education facilities and an insufficient demand for labour in the Ethiopian economy. Compared to the neighbouring countries, the investment in marketing facilities, local processing industries and insurance is unexplored (Ndikumana *et al*., 2000). The poor asset base of the growing livestock dependant population in the Borana rangelands is thus a structural cause for the detrimental impact of droughts.

In this context, the role of wealthy herd-owners for more sustainable livelihoods merits deeper investigation. The owners of larger herds were traditionally expected to voluntarily contribute to public goods (Baland and Platteau, 1997). This corresponds to the traditional obligation of wealthy Borana for the rehabilitation of impoverished households after a drought (*buusa gonofaa*), their contributions for the maintenance and reconstruction of deep wells, and for defence and cultural celebrations (Helland, 1996). The generosity of individuals was orally memorised in traditional narratives or in the cattle songs of the Borana pastoralists. However, through the commercialisation of the livestock economy, including individual possessions and external sources of capital, the wealthy herd-owners started acting against the community-based development, over-charging the communal rangelands with large herds, and stabilising their possessions through rapid re-investment in herds after a drought. It is argued here that the involvement of wealthy herdsmen into planning, improved investment and organisational capacities is an important component of ensuring food security in the Borana rangelands.

Another threat to IK-based range management is the ecological degradation of the rangelands, which directly affects livestock production. The range condition assessment of Dalle (2004) showed that the formerly highly productive Borana rangelands were only fair in condition and this was confirmed by another study of Oba *et al*. (2000b). The grass biodiversity was found to be very poor, with a very low proportion of excellent forage grasses, while unpalatable grasses have expanded. The bio-mass production was classified as poor, and was during the rainy-season in the Borana rangelands much less than in similar semi-arid ecosystems. One of the biggest problems of the Borana rangelands is woody species encroachment. Woody species have increased from ≤40% in the late 1980s (compare Coppock, 1994) to an average of 52% in the beginning 2000s, and the region has now crossed the boundary between grassland and shrub invaded grassland (Dalle, 2004). The Borana pastoralists are observing the declining quality of grazing resources and the reduced herbaceous yield (compare Photo 1). The ban on rangeland burning certainly plays a major role for the rapid woody species encroachment in rainy-season grazing areas such as Dida Hara. In accordance with Coppock (1994), it is concluded that in Borana rangelands the high grazing pressure over the last 30 years, associated with a lack of mobility in response to changes in forage and water availability, has further contributed to the rapid degradation[61].

4.4.4 Pastoralists' adaptation to changing frame conditions

Undisturbed IK-based rangeland management based on herd mobility and extended institutional networks would be the best scenario for using the ecological potential in the Borana rangelands. However, the conditions have changed and several IK based strategies are getting abandoned, such as the rangeland evaluation by experienced scouts (*aburro*), thematic meetings about rangeland management (*marri, kora*), early morning herding (*warree*), seasonal watering and salt feeding as well as the controlled burning practices (*guba*, *gursumeessa, furra*). This raises the question, if the Borana pastoralists have taken any measures to preserve IK-based range management and to adapt them to the new conditions. Indeed, Borana pastoralists have started to adopt foreign ownership concepts in crisis situations and have thereby weakened the ability to protect their communal interests. They

[61] Data about livestock populations in Borana are incomplete, but it is assumed that over the last 30 years livestock has been maintained at a high level despite the droughts (Helland, 1997). Coppock (1994) assumed that above 20 cattle km^{-2} density dependent effects would lower calving rate and milk yield.

established exclusive rights on land via crop cultivation, mainly after the heavy drought in 1984/85, initially as mechanism to cope with increasing food insecurity (Helland, 2000). The Ethiopian national law did not recognise the collective rights, which enabled pastoral livestock production. Instead, individual land tenure was guaranteed by land tax for cultivated fields. The *gumi Gaayo* of 1988 acknowledged crop cultivation as a means to enhance food security (Shongolo, 1995). Then, the *gumi Gaayo* of 1996 revised crop cultivation as primary cause for the privatisation of rangelands and decided to subject crop cultivation to the interest of the Borana society as a whole (Tache, 2000b). Similarly, fencing-off of commonly used forage-banks (*kallo*) was originally adopted from the neighbouring Gujji tribe as an adaptive response to the decline of grazing resources, and it was certainly influenced by the demonstration of commercial ranching (Oba, 1998). The development of the forage-banks as a tool for managing common grazing-reserves in order to avoid the fragmentation of the rangelands was approved by the *gumi Gaayo* in 1988 (Shongolo, 1995). After the private appropriation of rangelands, the *gumi Gaayo* in 1996 explicitly rejected the individual ownership of forage-banks. As Tache (2000a, 2000b) reported the water cistern development has initiated the debate on the risk of rangeland and water commercialisation at the wells. These examples show that the Borana pastoralists try to adapt foreign concepts. But under pressure and an emerging dual system of production they risk *de facto* privatisation by rich herd owners. The communities attempt for more controlled land use under the increasing scarcity, trying to preserve the principles of communal tenure arrangements and to correct misleading claims. The conflicting claims and the institutions involved provide starting points for what many authors have stressed as strengthening the capacity of local institutions (Behnke, 1994; Swift, 1995; Knox and Meinzen-Dick 1999; Turner, 1999).

Recently, Borana communities have started to re-strengthen the control over natural resource utilisation by restricting encampments. The communities have realised that their power and competence for the control of herd movements have largely been lost (A8 in ATable 1). Especially, the pastures near to the encampments and traditionally reserved for the milking herds, are endangered by over-grazing. Counteracting these unfavourable conditions, the elders' committees in Dida Hara and in Web have managed to design directives for a modernised mobility, based on IK. They initiated negotiations with the PA committees to re-establish *dongora seera,* the indigenous principle of restricted encampment. The main objective was to regain control over the access to pastures for the lactating herds near the encampments, and to stop the ongoing scattering of encampments leading to fragmentation of the communal grazing areas. Therefore, the accountability of households for herds and land

use was enforced. The right of access to pasture shall be linked to the location of the encampment. Only permanent encampments, managed by at least one adult woman[62], and in proper location along the line, shall get the allowance for grazing of lactating and non-lactating animals. Forage-banks shall be restricted to areas commonly used by groups of camps and no longer be fenced privately. The fencing of cropping areas shall be limited to a maximum size of 1.5 ha per household and set-up near the camps. The PA administration was involved to enforce the decisions at the community-level. The government was asked for support, and to delegate the ownership over rangeland resources to the communities and to preserve community-controlled grazing areas. It was observed during the research phase that in most cases, encampments, crop cultivation fields and common grazing reserves were re-located within the agreed time frame.

Thereby, the Borana pastoralists have induced what is recommended as co-management, co-operative arrangements between local institutions and the formal administration (Leach *et al*., 1997; Kirk and Grell, 1999; Niamir-Fuller and Turner, 1999). Their priorities reflect the necessity to maintain a flexible rangeland management, sustained by limiting the number of pastoral households in home-based grazing areas and transfer-out of excess livestock. The actions revealed controlled encampments as an instrument for limiting herd sizes per most critical grazing resources, which is developed by the communities and possibly useful to elaborate further regulations. The communities' options are in line with the argument of Sandford and Habtu (2000), that the preservation of a minimum of commonly shared pastures may gain in importance as one of the key measures to maintain rangelands for many households instead of enabling a few rich taking control of the commons. Or, as McCarthy (1998:31) has concluded, that especially for the poor and marginalised households maintaining access to common rangelands "*...is of utmost importance in reducing the riskiness associated with climatic variability*".

The study underlines the proposition of Watson (2003), that range management committees at PA-level would present a great potential to channel IK-based development. The Borana elders have initiated a co-management with the PA-committees, despite all deficiencies and a strong distrust. This is a very strong point for hybrid forms of community-based organisations where

[62] According to Borana definition, the presence of an adult woman provides the status as permanent encampment instead of a satellite camp.

the government has coercive power. As Ngaido (2002) pointed out, the common basis for legitimacy in negotiations between the traditional and formal institutions needs be emphasised. In the Borana case, there is a strong need to develop election modes for the PA representatives who are accepted by the pastoral communities, and to upgrade the local officials in range management and livestock knowledge.

Furthermore, an appropriate allocation of user rights has to respond to the well established institutional components which are still operative even under the constrained conditions. This starts from acknowledging the principle of experience-based decision making after common agreement (Lane and Morehead, 1995; Bassi, 1996). The Borana still maintained thematic assemblies as the forum for common decision making even under the many external disturbances. Important elements of the assemblies were identified as the community's selection of qualified participants, intense consultation among the experienced delegates, strict rules on procedures and responsibilities, flexible response to individual cases, community affairs at clan or at locality-level, up to issues that concerned the entire Borana society and accommodated relationships with outsiders. The enforcement of decisions is critical under conditions of ongoing climatic, socio-economic and political instability. The pastoralists' patterns of decision making are typically *ex post*, and facilitate adaptation to emerging situations (Van den Brink *et al.*, 1995; Mortimore, 1998). It is argued that sustaining these principles is important to create legitimacy in structures for continuous negotiations over the use and maintenance of common range resources, including conflict mediation and arbitration between different interest groups (Niamir-Fuller and Turner, 1999; Thébaud and Batterbury, 2001). The danger is the abuse of power and inequality in access to information, markets and political alliances, exposing disadvantaged groups even more to manipulation (Ensminger and Rutten, 1991; Swallow and Bromley, 1995; Edmunds and Wollenberg, 2002).

The Borana pastoralists' have also adapted their breeding and selection preferences to the deteriorating conditions of their environment. Facing the degrading ecological conditions pastoralists accepted the small frame *ayuna* breeding type as the second-best choice, and appreciated its better adaptation to poor grazing conditions. The high share of the intermediate cattle type in Dida Hara indicates the start of more diversified breeding objectives within a herd of cattle. The pastoralists' judgement about Web being favourable grazing area for the *qorti* seemed contradictory to the results of the range ecology study (Dalle, 2004) that the central area of Web was actually more degraded than Dida Hara. However, Web is adjacent to

the best *Wayama* rainy-season pastures in the East (compare Map 4), and a higher mobility of herds was found in Web, which allows access to high quality pasture for *qorti* cattle. Conservation of the true Ethiopian Boran cattle would thus require improvements in the quantity and quality of grazing resources available to the Borana pastoralists. For the long term valorisation of the Borana range and livestock resources the definition of users who have the necessary technical capability, is a critical priority at the local-level. Herders' adaptation of breeding preferences is reported by Adams and Kaufmann (2003) on dromedary breeding in Kenya or by Krätli (2002) on cattle husbandry in Nigeria. Combining several breeding types within the herd seems a mechanism to reduce risk and to take advantage of different feeding behaviour, productivity and endurance. In agreement with Köhler-Rollefson (2002), the animal genetic diversity should be preserved, being an important asset of the adaptive capacity of the pastoralists.

Changes were also reported in herd management. The Borana herdsmen have abandoned the keeping of castrated males (*sanga*). Loosing the castrated males is interpreted as an indicator for insufficient forage and a lack of management capacity for satellite herds. As an important economic reserve for drought coping, the *sanga* had prevented households to deplete their herd resources for subsistence needs and reduced their vulnerability to market forces. Under current conditions, the commercial off-take of the impoverished households included even lactating cows, further undermining the households' food security and capacity for post-drought recovery (for off-take rates compare chapter 5.3.3). As Doyo Dulatscha, a Borana elder from Dida Hara (pers. comm., 2001) explained, the reduced satellite herds leave more grazing resources for the lactating herds, but remote pastures could become under-utilised, and the dependence on the lactating herd's increases.

Furthermore, in response to the perceived ecological degradation, pastoralists have complemented cattle and auxiliary small stock husbandry with that of dromedaries[63]. Dromedaries have been only recently adopted, but already more than 50 % of the Borana households have started keeping them (AFigure 1; AFigure 2). Dromedaries are known to be better adapted to the degraded rangelands and that they could provide additional transport services and a more reliable milk production. Although they have no traditional value in the Borana culture, they are now seen as indispensable elements of the Borana pastoral

production system. Huqa Garse, a rural development advisor (pers. comm., 2001), has confirmed a positive change in the Borana pastoralists' attitude towards keeping dromedaries. But the productivity of the dromedaries in the Borana systems is low and this reflects the distress caused by the droughts, aggravated by the lack of management knowledge for dromedary husbandry of the Borana pastoralists.

4.4.5 Scenario for mobile range management

The findings of this study attest that the Borana pastoralists have the ability to adapt their organisational and management structures to the degrading environment, making use of their IK. But this has not been realised due to the Ethiopian policy frameworks. Since the control of rangelands through limited water is no longer feasible, new regulations for improved range management have to be put in place taking account of the reduced mobility. It would demand a strong external support to re-strengthen and modernise the indigenous decision making structures. The results obtained from the multi-stakeholder workshops (ABox 5) suggest focussing future research and development on how to integrate IK-based range management and formal administrative structures, supporting co-management. Reinforcement of local authorities was acknowledged as first priority to achieve land use planning that accounts for the changed conditions. The role of the government was portrayed as a facilitator to enforce the decisions. Mobility was controversially discussed; it was seen as a necessity to respond to the erratic rainfalls and heterogeneous rangeland resources, but its utilisation seemed increasingly difficult as long as the frame conditions are not improved. To reinstate mobility as a tool for more sustainable rangeland management, the following priority measures and institutional responsibilities (compare Figure 10) should be revised and strengthened at the local-level (Box 1):

[63] Modes of adoption of dromedaries are also reflected by the origin and breeds of Borana pastoralists' livestock species. They indicate high transfer-in from the Somali (ATable 22ATable 23).

1. restricted allocation of encampments, authorised by local land use committees (*jarsa ardaa*) and formal arbitration at the *PA*-level;
2. community controlled external grazing reserves (*foora*), co-ordinated by mobile herder committees (*jarsa dheedhaa*) and formal arbitration at woreda-level;
3. indigenous governance system (*gadda*) for participatory monitoring and evaluation of the land use planning process, especially after droughts or conflict induced perturbations, backed-up by capacity building and development planning at the regional and federal-level;
4. mediation between the communities and in contact with outsiders by sensitised target group representatives (*abba quaee, jallaba* or *hayyu*), backed up by informed development agents.
5. enabling information systems on pasture quality, water availability and disease risk, targeting key persons and strategic locations for information transfer (f.ex. range scouts, water managers, market places, watering wells and ponds)

Box 1. Model structure for rangeland management with assistance of Borana pastoralists' IK.

The developed scenarios for restructuring mobile range management deem feasible and are socially accepted, and are therefore expected to preserve legitimacy for rangeland development in Borana rangelands. They correspond to the need for land use intensification, preserving basic preconditions for mobility and also improving access to marginal rangeland resources. For secured access and rehabilitation of rangelands they however need an official recognition and support from the government. The ongoing environmental degradation threatens many pastoral households' with poverty. Whether poverty and other socio-economic characteristics of households affect the utilisation of pastoralists' IK in range management strategies is explored in the next chapter.

5 SOCIO-ECONOMIC PRECONDITIONS FOR THE USE OF PASTORAL INDIGENOUS KNOWLEDGE

5.1 HYPOTHESIS

Due to the shrinkage of available natural resources in the Borana rangelands livestock production became insufficient to sustain the pastoralists' livelihood. Factors additional to climate gained an influence on the natural resource-based economy of the Borana pastoralists and related rangeland management practices. Kamara (2001) found that socio-economic variables such as an increasing heterogeneity in wealth, off-farm opportunities and social capital explain a loss in community co-operation in managing natural resources. He also observed an increasing reliance on crop cultivation and privatised grazing. Furthermore, mobility as the principal pastoral land use strategy had been reduced and was now applied under restricted conditions. The pastoralists invested in dromedaries and small ruminants and thereby sustained flexibility through herd diversification. This led to the question, what type of household could still afford to maintain mobility, what type invested in herd diversification, and whether certain socio-economic characteristics were a prerequisite for households to apply IK. Therefore, a second hypothesis is postulated:

2nd hypothesis **Socio-economic household characteristics determine the application of indigenous knowledge-based range management strategies.**

This hypothesis was tested by selecting the core strategies of opportunistic range management as dependant variables: (1) Mobility was selected as the primary adaptive strategy by which the pastoralists respond to the erratic natural environment. (2) Herd diversification with a higher fraction of browsers was regarded as a supplementary strategy by which pastoralists improve the utilisation of the increasingly with woody species invaded grasslands. (3) Households decision to adopt dromedaries was tested additionally, because the Borana herdsmen have adopted dromedaries recently. The independent variables were socio-economic household characteristics, which had been selected from information based on their importance reported in the literature and own observations, and were transformed into specific categories.

These socio-economic household characteristics were tested as determinants for the three indicators of applied IK and the interaction among the indicators for applied IK was investigated. The impact of the sample locations on the IK-variables was also considered.

Finally, the impact of mobility, herd diversification and adoption of dromedaries on herd

performance was assessed. The mortality rate was selected as indicator for successful herd management during droughts, expressing the ability to avoid herd losses due to death. The net herd growth rate was used as indicator for successful herd rehabilitation after droughts.

5.2 METHODS

5.2.1 Data collection

The in-depth study of socio-economic household characteristics started in December 2001, one year after the initial data collection (A13 in ATable 1). Becoming more familiar with the target groups was important to establish a more confidential relationship and to conduct the sometimes difficult and sensitive questions. The survey was addressed to a sub-sample from the socio-economic baseline survey, randomly selecting 10 households in each of the six encampment clusters. The survey consisted of semi-structured questions on the availability of manpower and seasonal labour allocation, in- and outflows of their herds during the year at the late stage of the drought (March 1999 – February 2001), and the first year after the drought (March 2001 – February 2002), non-livestock assets, income generation and expenditures. The data obtained during the socio-economic baseline household survey (A12 in ATable 1) provided basic information and were used for cross-checking. As explained in chapter 4.2.1, the data were assessed with reference to the drought cycle, and included fix household characteristics (age of head of household, consumption units, manpower, number of spouses, education, livestock marketing, income diversification, location, relief, extension), variable household characteristics (herd size and herd dynamics, co-operation, human support capacity, adoption of dromedaries), and those which could only be measured for the time after the drought has passed (crop cultivation, cash income, equipment). The questionnaires had been extensively tested for content and comprehensibility and modified accordingly. The questions were addressed to the head of household, preferably in consultation with his wife. The interviews took place at the homestead.

This was followed by an in-depth assessment of mobility (A6 in ATable 1). It was started in March 2002 and applied to the same sample households as of the socio-economic in-depth study. The semi-structured questionnaires provided quantitative information about livestock specific movements over a 24 months period during the late stage of the last drought (March 1999 - February 2001) and a 12 month period after the drought has passed (March 2001 - February 2002). For both periods the informants were asked about the name of the destination, and to estimate the distance to their encampment and the duration per each

movement of cattle, small ruminants and dromedaries. The names of the places were recorded and cross-checked by land use mapping with key persons.

5.2.2 Data processing and analysis

Data entry and graphical design was done in Microsoft ® Excel 2000. Statistical analyses were performed by using the SPSS software package, Version 10.0 selecting mainly the procedures PROC FREC, PROC CORR, PROC NPAR TESTS, PROC PLUM, PROC UNIANOVA and PROC LOGISTIC REGRESSION.

The dependent variables measuring Borana pastoralists' applied IK at household-level were defined as follows, and measured separately for the different periods within the drought cycle:

- Mobility: The estimated monthly walking distances of each livestock species were summarised, separately for the observation periods during and after the drought. Weighing factors were applied to account for different efforts to move the different species (cattle = 1, small ruminants = 0.6, dromedaries = 0.8). Then, the aggregated distance in movements (km) was converted in mobility as an ordinal variable with categories of low (1), medium (2) and high (3) mobility. The transformation of mobility in km per household into ranks deemed necessary, because linearity in distance between the changes of mobility as the outcome of different socio-economic effects could not be assumed. Furthermore, the mobility data are based on pastoralists' estimations, but could not be verified by exact measurements. The results are therefore limited to predict trends in the adoption rates of mobility rather than metric interrelationships. The transformation into categories of mobility is based on thresholds, which were calculated by the mean monthly walking distances, weighted by the livestock specific factors, $\pm$ 95% confidence interval. This allowed classify a group of medium mobility and of mobility which is significantly below the medium, and another which is significantly above the medium. Additionally, the pastoralists' criteria for ranks of mobility were integrated (A3 in ATable 1). Pastoralists considered the fact that a household moved at least his cattle, and that he shifted the cattle herd at least twice as further qualifications for being ranked as medium or highly mobile (ATable 2).
- Herd diversification: The Simpson Index (SI) of species diversity was adopted from

Ndikumana *et al.* (2000) to convert herd diversity to metric numbers. The index was calculated using Tropical Livestock Units (TLU household^{-1})[64], putting emphasis on the adaptation of the herds' nutritional requirements to the changing ecological environment, and was applied for each household as follows:

$$\frac{\{(\text{TLU cattle}^2) + (\text{TLU small ruminants}^2) + (\text{TLU dromedaries}^2)\}}{(\text{TLU total})^2}$$

SI values tending towards 1 signalised dominance by a single species, whereas towards 0 they signalised a greater diversity.

Additionally, the percentage of small ruminants and of dromedaries was measured in heads of livestock (n household^{-1}), for comparing the share of livestock species complementary to cattle in terms of management requirements.

- Adoption of dromedaries: The adoption of dromedaries per household was described as a dichotomous dependent variable which could only take the value of without dromedaries (1) or with (2).

The following independent variables were hypothesised to influence the applied degree of Borana pastoralists' IK at household-level, and were used as regressors:

Metric variables:

- Herd size: The total head of livestock were used as reference unit, and included cattle, small ruminants and dromedaries. It was assumed that the minimum requirements in management to maintain livestock in additional herds were similar.

Ordinal variables:

- Age of head of household: The classification was done according to local estimations into young (< 40 years) (1), medium (40-55 years) (2) and old (> 55 years) (3).
- Consumption units: For comparative purposes the family size was converted into African Adult Male Equivalent (AAME) (ATable 24). The calculation was based on recommendations for the average daily food energy requirement of an active African

[64]For comparative purposes on nutritional aspects livestock was converted in the Tropical Livestock Units (TLU) with 1 dromedary = 1 TLU, 1 cattle = 0.7 TLU and 1 small ruminant = 0.1 TLU. The concept of TLU is conventionally used to integrate mixed species herds and nutritional needs (Jahnke, 1980).

Adult Male being 2530 kcal (FAO, 1974). The categories were based on sex and age. The mean size of consumption units was calculated, ± 95% confidence interval. Households were classified into categories of small (< 5.00 AAME) (1), medium (5.00 – 8.79 AAME) (2) and large (> 8.80 AAME) (3) consumption units.

- Manpower: For comparative purposes the manpower was defined as the sum of labour supply by all labour units, with weighting factors derived from pastoral studies of Abdullahi (1990) and Rahman (1995), and corrected by own observations (ATable 25). The categories were based on age. Children and teenagers were weighted by comparatively high factors, because they were the main responsible for daily herding tasks up to 14 hours per day. Pupils were only partly available and received the lowest weighting factor. Both sexes seemed equally engaged in livestock management, and no extra weighting factor was applied. The mean size of manpower was calculated, + 95% confidence interval. Households were classified into categories of low (< 2.95) (1), medium (2.95 – 4.99) (2) and high (> 5.00) (3) manpower.
- Number of spouses: The marital status was classified in female headed (1), having one spouse (2) or more than one spouse (3).
- Education: The heads of households normally had not received formal education. Therefore the standard of education was determined by the level of education supplied to their children. Households were classified in groups with no access to formal education (1), to primary education (2) and to secondary education (3).
- Co-operation: According to the local estimations not co-operating in a mobile herding group (1) was distinguished from moving in small herding groups of maximum 4 households (2), and moving in large herding groups of more than 4 heads of household up to the whole village (3).
- Livestock marketing: Different markets for the sale of livestock could have been frequented. Considering distance and functionality of markets (ATable 26), households were classified in groups with no access to regional markets and/or sale on local markets only (1), sale to regional markets, including primary and/or secondary markets (2), or sale also on export markets (3) (modified according to Teka *et al*., 1999).
- Income diversification: The sources of cash income differed. Households were classified in groups with no cash income and/or cash income derived from livestock and/or livestock products only (1), additional on farm income (2), and additional off-farm income (3).

- Cash income: The annual amount of cash income during the post-drought year was converted by a Lowess transformation and classified into categories of low (< 1000 ETB[65]) (1), medium (1000 – 10000 ETB) (2) and high cash income (> 10000 ETB) (3), by splitting at mean $\pm$ 95% confidence interval.

Nominal variables:

- Location: Dida Hara (1) was the former rainy-season grazing area and of high external interference. Web (2) was the traditional dry-season centre where external interference was comparatively low.
- Human support capacity: The threshold for survival was derived from calculations by Sandford and Habtu (2000) as above 3 TLU $AAME^{-1}$. Households below the threshold were considered as famine vulnerable and physically not able to survive when depending on livestock husbandry. Households were classified as below (1) or above (2) the capacity of 3 TLU $AAME^{-1}$.
- Adoption of dromedary husbandry: Households were classified as either not keeping dromedaries (1) or having at least one (2).
- Crop cultivation: The pastoralists defined 1.5 ha cultivated land per household to be the minimum requirement for sustained food security (compare A8 in ATable 1). Households were classified as below (1) or above (2) the holding of 1.5 ha cultivated land per household.
- Equipment: The pastoralists identified ownership of equipment as productive assets others than the herd size (A12 in ATable 1; ATable 27). The items were then weighed by factors of local peculiarity and the ranks the pastoralists attributed to them. The sum of the aggregate equipment was split by mean $\pm$ 95% confidence interval. Households of the lowest third were classified as of below (< 3 equipment ratio) (1) and the remainders as above ($\geq$ 3 equipment ratio) (2) the minimum equipment.
- Relief: Households were classified as without reception of relief (1), or having received relief (2) during the last drought.
- Extension: Households were classified as either without experience with extension service

[65] Ethiopian currency, with current value equal to 1 ETB = 0.1 € (http://www.oanda.com/convert, visited 2004)

(1), or having experienced extension (2).

The impact of drought on the application of the IK-variables was tested by the uni-variate sign test, a non parametric procedure for two related samples. Therein, the differences between two variables are calculated for all cases and classified as positive, negative or fixed. If both variables are similar, then the test decides that the positive and negative differences are not significant.

The levels of statistical significance were conventionally defined and marked as

- $p<0.01$ = distinct significance (**); $p<0.05$ weak significance (*);
- $p<0.1$ = at the lower bound of significance (°); $p \geq 0.1$ = no significance (n.s.).

Distinct significant interrelationships among the following explanatory variables were expected, and were examined using Spearman Rhodes' rank-correlation (**):

- Consumption units ** manpower ** spouses, before and after the drought
- Herd size ** human support capacity, before and after the drought
- Herd size ** human support capacity ** equipment ** cash income, after the drought.

Different statistical procedures were used to analyse the effect of the socio-economic household characteristics related to the specific IK-variables. The procedures were run separately for the different periods within the drought cycle:

- The ordinal regression model was selected to identify the socio-economic determinants of mobility. Ordinal regression determines the dependence of an ordinal categorical response variable on a set of discrete and/or continuous independent variables (McCullagh 1980, 1998). Deficiency in ordinal regression is that it is a recent procedure. Repetitions are not feasible and hence the impact of drought could not be integrated within the same model (Hollenhorst, JLU Giessen, pers. comm., 2003). The regression analysis of the mobility variables started with a pre-selection of significant discrete explanatory variables using Spearman Rhodes' rank-correlation for the metric variable and the Pearsson's χ^2 test for the categorical variables. The procedure was accomplished using the -2log-likelihood test for different sets of the selected explanatory variables. Significance in parameter estimation was compared to the goodness of fit measures, Pseudo R^2 and the estimated cell response probability in order to find the best cumulative response probability of the model.
- The analysis of variance was selected for providing highest information accuracy about

the differences in herd diversity (SI) caused by socio-economic household characteristics. First, linear relationships between herd diversity and herd size as a metric number and the ordinal socio-economic household characteristics were tested using Spearman Rhodes' rank-correlation. Significant differences between herd diversity and the nominal variables were cross-checked using the median test. Then, subsets of significant explanatory variables entered the analysis of variance. In addition, the effects of the socio-economic characteristics were differentiated for the proportion of small ruminants and dromedaries in the herds, using Spearman Rhodes' rank-correlation and median test.

- The logistic regression model was selected to explore the determinants of the adoption of dromedaries. The logistic regression for adoption of dromedaries was run entering all variables and the forward likelihood-ratio (LR) test was used for the selection of the explanatory variables. The significant parameters were cross checked by median test and χ^2 test.

For each IK-variable, the impact of the sample locations was considered, by descriptive statistics and χ^2 test. Subsequently, the interactions among the IK-variables herd mobility, herd diversification and adoption of dromedaries were analysed, using Spearman Rhodes' rank-correlation and χ^2 test.

Finally, the effects of the IK-variables were tested on selected indicators for successful herd management, defined by the inflow and outflow rates of cattle, small ruminants and dromedaries (A12, A13 in ATable 1). Denominators for inflow and outflow rates were the herd sizes at the beginning of the observation period (Ndikumana *et al*., 2000). The nominators included the following parameters:

Inflows

NBI = Number born during the observation period
NPU = Number purchased during the observation period
NGI = Number got as gift during the observation period
HB = Herd size at the beginning of the observation period

Outflows

NSO = Number sold during the observation period
NDE = Number of death during the observation period
NGO = Number transferred out during the observation period
NSL = Number slaughtered during the observation period
HB = Herd size at the beginning of the observation period

The mortality rates (MOR) were calculated as an indicator for successful avoidance of deaths during drought:

$$\text{MOR} = \frac{NDE}{HB}$$

The net herd growth rates (NHG) were calculated as the indicator for successful reconstruction of herds after drought:

$$\text{NHG} = \frac{NBI + NPU + NGI - NSO - NDE - NGO - NSL}{HB}$$

The frequency of the mortality rates and net herd growth rates were depicted for Dida Hara and Web, and significant differences were exposed, using the T-test. The inherent inflows and outflows of the herds were described for explanatory reasons. Then, differences in the selected indicators for successful management caused by the IK-variables were tested for the different livestock species by analysis of variance, using the F-test. Mobility and adoption of dromedaries entered as fixed effects, and herd diversification as a co-variate. Significant impact of herd diversity (SI) was cross-checked by Pearsson's linear correlation and Lowess regression analysis, the impact of mobility and adoption of dromedaries by Spearman Rhodes' rank-correlation. Additionally, the effects of the socio-economic characteristics on the mortality rates and on the net herd growth rates were tested, using Spearman Rhodes' rank-correlation and median test.

5.3 RESULTS

5.3.1 Determinants of herd mobility

The pre-selection (Spearman Rhodes' rank-correlation and Pearsson's χ^2)[66] and the ordinal regression model showed that the socio-economic characteristics affecting a Borana households' level of mobility differed between the period during the last drought (March 1999 - February 2001) and after the drought has passed (March 2001 - February 2002) (Table 12)[67].

[66] As explained in 5.2.2, the lowest bound of statistical significance was $p<0.1$.
[67] The relationships among the explanatory variables were calculated for the two periods within the drought cycle.

Table 12. Overview compiled for measured and significant determinants of mobility at household-level during and after the drought.

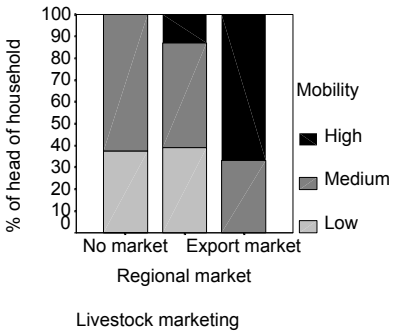
Household characteristics	-------During drought------		-------After drought-------	
	Sp. Rhodes / χ^2-sign.	ORDINAL REGRESSION	Sp. Rhodes / χ^2-sign.	ORDINAL REGRESSION
	Metric variable			
Herd size #			0.452**	
	Ordinal variable			
Age of head of household				
Consumption units				
Manpower				
Number of spouses				
Education				
Co-operation			0.000**	✓
Livestock marketing	0.009*	✓		
Income diversification				
Cash income			0.000**	
	Nominal variable			
Location			0.000**	✓
Human Support Capacity	0.043*		0.001*	✓
Adopt dromedaries			0.036*	
Crop cultivation				
Equipment				
Relief			0.069°	
Extension	0.095°			

= Spearman Rhodes' rank-correlation, others: χ^2 Test;
✓ = selected variable by the ordinal regression model.

For the period during the drought, socio-economic household characteristics influencing herd mobility in Borana rangelands were preselected to be the variables livestock marketing, human support capacity and extension (Table 12; Box 2):

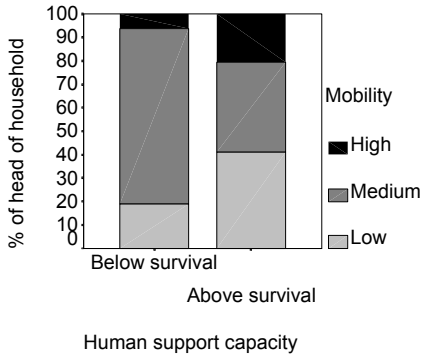
Livestock marketing ($p<0.01$):

Households with access to the export market Moyale were predominately highly mobile (67%) or medium mobile (33%), and low mobility did not exist. In contrast, households with no access to regional markets were medium (62%) or low (38%) in mobility. Households using regional markets showed medium mobility (48%), low mobility (39%) and high mobility (13%) (compare diagram).



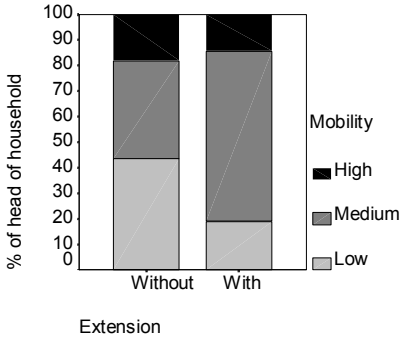
Human support capacity ($p<0.05$):

Livestock assets below the threshold for survival (3TLU AAME^{-1}) led to predominantly medium mobility (75%), but also low mobility (19%) and high mobility (6%) occurred. Above the threshold for survival the proportion of households with low (41%) and high mobility (21%) was more pronounced (compare diagram).



Extension ($p<0.1$):

Experience with extension was predominantly combined with medium mobility (67%), and similar shares for low mobility (19%) and high mobility (14%). The group of households without extension showed a higher share of low mobility (44%), 39% of medium mobility and 18% of high mobility (compare diagram).



Box 2. Frequencies of socio-economic determinants for herd mobility during the drought (n=60).

Among the explanatory variables for mobility during the drought livestock marketing and human support capacity were strongly correlated, but not so with extension. This indicated that during a drought households with sufficiently large herds are more likely to sell livestock on bigger markets and thereby can enhance their flexibility.

The ordinal regression model was then applied to the significant household characteristics livestock marketing, human support capacity and extension. The model started in an iterative process with the three significant characteristics, and selected the single variable livestock marketing as most likely determining a household's decision for mobility (parameter significance at 0.003 and 0.001) (Table 12, ABox 1). The variables human support capacity and extension fell below the lower bound of significance, but improved the cumulative response probability of the model. Goodness of fit measures, Pseudo R^2 and the estimated cell response probability were applied to cross-check the statement given by the model. The results for Y_1 indicated a satisfying goodness of fit (Pearson χ^2 significant at 0.651, deviance significant at 0.467), but only relatively low values for Pseudo R^2 (Cox and Snell at 0.218, Nagelkerke at 0.251 and McFadden R^2 at 0.121)[68]. Based on the maximum likelihood estimate, the model allowed predicting a cumulative total of 63.3 % of the cases correctly. It improved the prediction by the most frequent category, which was for medium mobility only 48.3 % (model information significant at 0.005). A critical remark is that major deviation occurred in the estimated cell response for low mobility, when 14 cases were predicted correctly, but also 3 cases of high mobility have been observed. Excluding human support capacity and livestock marketing would have deteriorated the cell response probability to 51.7%, with no prediction of cases with low mobility.

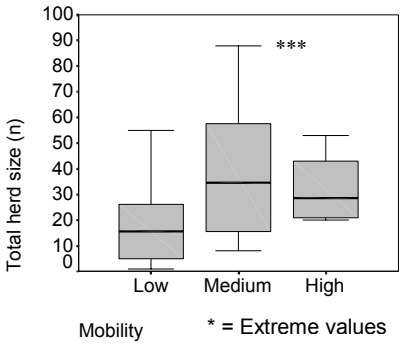
Therefore, the critical variable for those Borana households who applied mobility during the drought was identified as the access to markets, especially to export markets. During droughts the conditions to decide for mobility are determined by scarcity, so that precise predictions about the application of mobility are unlikely.

[68] Several values for R^2 and goodness of fit are documented, because the ordinal regression cannot explain the variance and therefore lack accuracy (Hollenhorst, JLU Giessen, pers. comm., 2003).

For the period after the drought, the socio-economic characteristics influencing herd mobility in Borana rangelands were preselected to be the variables herd size, co-operation, location, human support capacity, adoption of dromedaries, cash income and relief (Table 12; Box 3):

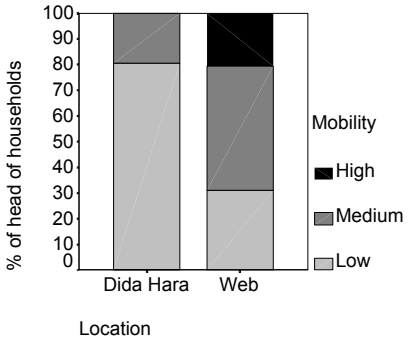
Herd size ($p<0.01$):

The lowest mean herd size was found in the low mobility group (mean 18, se 16), followed by the high mobility group (mean 32, se 13), and the largest size for medium mobility (mean 94, se 156). The households with the largest herd size were mainly found in Dida Hara and only showed a medium level of mobility because throughout the year these herds were shifted between two locations (for median values compare the box-plot).



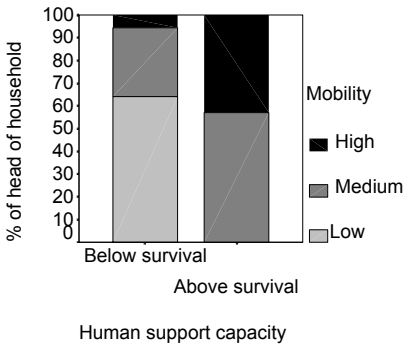
Location ($p<0.01$):

The probability for greater mobility was higher in Web. The share of low mobility was less in Web than in Dida Hara (31% vs. 81%), and high mobility was existent (21% vs. 0%). Medium mobility was for 48% of the households in Web and for 19% in Dida Hara (compare diagram).



Human support capacity ($p<0.05$):

Above the threshold for survival households were at least medium mobile (57%) or they were highly mobile (43%). Below the threshold for survival 64% of the household showed low mobility, 30% showed medium mobility and only 6% showed high mobility (compare diagram).



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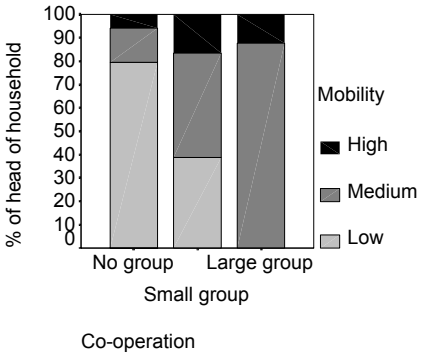
Co-operation ($p<0.01$):

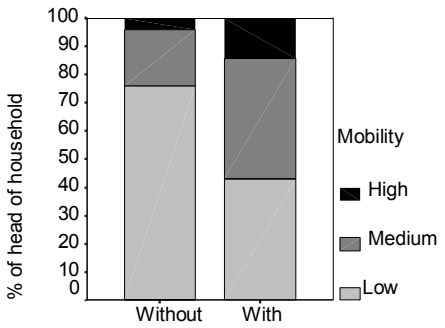
Mobility increased when households were part of larger herding groups. With access to large herding groups no low mobility was found, but 88% medium mobility and 12% high mobility. With access to medium herding groups 17% of the households were highly mobile, 44% medium and 39% low in mobility. Without access to herding groups 79% of the households were almost immobile, 15% showed a medium mobility and only 6% were highly mobile (compare diagram).



Co-operation

Adoption of dromedaries ($p<0.05$):

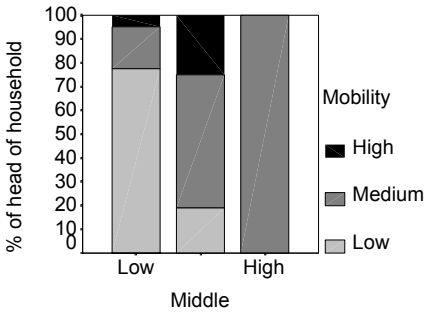
Households with at least one dromedary had a lower share of low mobility than those without (43% vs. 76%) and a higher share of high mobility (14% vs. 4%). Medium mobility was observed for 43% of the households with dromedaries and 20% of the households without dromedaries (compare diagram).



Adoption of dromedaries

Cash income ($p<0.01$):

Higher cash income favoured mobility. The high income group was exclusively composed by households with medium mobility. In the medium income group 56% of the households showed a medium mobility, 25% showed a high mobility and 19% of the households showed a low mobility. The share of low mobility was highest in the low income group (79%), with only 16% of the households practising a medium mobility, and 5% a high mobility (compare diagram).



Cash income

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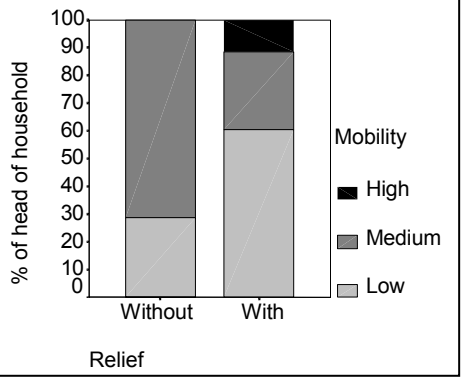
Relief ($p<0.1$):

Households with access to relief had a higher share of low mobility than those without (60% vs. 29%) as well as a higher share of high mobility (11% vs. 0%). Medium mobility was observed for 72% of the households with relief and for 28% of the households without relief (compare diagram).



Box 3. Frequencies of socio-economic determinants for herd mobility after the drought (n = 60).

Among the explanatory variables for mobility after the drought, herd size, co-operation, location and human support capacity were strongly correlated, but no relation was found with relief. This indicated that after the drought households in Web with larger herds were more likely to co-operate in larger herding groups.

The ordinal regression model was then applied to the significant socio-economic characteristics herd size, location, co-operation, human support capacity, adoption of dromedaries and cash income. In the iterative procedure, the model selected among the six significant characteristics the variables location (parameter estimation significant at 0.001), co-operation (parameter estimation significant at 0.008 and 0.253) and human support capacity (parameter estimation significant at 0.000) as most likely determining a households' decision for mobility (Table 12; ABox 2). The parameter estimation of adoption of dromedaries was not significant as such, but the variable improved the goodness of fit[69] (from Pearson's χ^2 significant at 0.000, deviance significant at 0.161 to Pearson's χ^2 significant at 0.017, deviance significant at 0.316), and the cumulative cell response probability (from 81.7% to 83.3%). In comparison to the regression of mobility before drought, goodness of fit measures turned out less satisfactory, but better values for pseudo R^2 appeared (Cox and Snell at 0.557, Nagelkerke at 0.662, McFadden at 0.443). The model, allowing a prediction of a total of 83.3% of the cases correctly, improved the prediction by the most frequent category, which was for low mobility only 56.66 % (model information significant at 0.000). The

[69] It was assumed that small values of significance would have suggested that the model is not adequate.

quality of the estimated cell response probability was not diminished by major deviation between prediction and observation.

The critical variables for those Borana households who applied mobility after the drought were identified as locations like Web with less development interference, access to larger co-operation groups for herding, and ownership of sufficiently large herds. After the drought, rainfalls replenished the accessible forage and water resources, the livestock populations were reduced and therefore the application of mobility was more predictable.

The sampling locations Dida Hara and Web were expected to show differences in mobility and in socio-economic determinants, due to a difference in the degree of external interference. As has been shown in chapter 4.3.1, the mobility was higher in Web than in Dida Hara after the drought. Furthermore, Dida Hara and Web revealed differences in the distribution of the following socio-economic household characteristics: The level of co-operation was differently pronounced in Dida Hara and Web, during both stages of drought (Table 13). Before the drought, Web was distinguished by the greatest amount of households with co-operation in large herding groups. After the drought no co-operation was predominant among households in Dida Hara. At both locations co-operation has been significantly reduced after the drought (sign test, $p < 0.01$).

Table 13. Frequency (%) of households' levels of co-operation in Dida Hara and Web before and after the drought (n = 60).

Co-operation	----------Before drought----------				----------After drought----------			
	Dida Hara	Web	df	χ^2-sign.	Dida Hara	Web	df	χ^2-sign.
	----------[%]----------				----------[%]----------			
No group	23	3	2	0.000	74	38	2	0.017
Small group	55	21			19	41		
Large group	23	76			7	21		

The experience with extension service was more prevalent for households in Dida Hara, which was closer to Yabello town, centre for development activities (Table 14).

Table 14. Frequency (%) of households' experience with extension in Dida Hara and Web and significant differences (n = 60).

Extension	Dida Hara	Web	df	χ^2-sign.
	----------[%]----------			
Without	55	76	1	0.088
With	45	24		

The proportion of households who cultivated more land than the minimum for food security (1.5 ha household^{-1}) after the drought, was in Dida Hara double than in Web (Table 15).

Table 15. Frequency (%) of crop cultivation in Dida Hara and Web and significant differences after the drought (n = 60).

Crop cultivation	Dida Hara	Web	df	χ^2-sign.
	----------[%]----------			
< 1.5 ha	52	76	1	0.051
> 1.5 ha	48	24		

The distribution of annual cash income after the drought was more disproportional in Dida Hara than in Web, with more households disposing of higher cash income and more households disposing of lower cash income (Table 16).

Table 16. Frequency (%) of cash income in Dida Hara and Web and significant differences after the drought (n = 60).

Cash income	Dida Hara	Web	df	χ^2-sign.
	----------[%]----------			
Low	80	52	2	0.008
Medium	10	45		
High	10	3		

The locations of Dida Hara and Web thus differed in the socio-economic situation of the households. Dida Hara, in comparison to Web, had experienced a high external intervention in the 1970s. Households in Dida Hara have currently shown less interest in co-operative herding groups during both stages of drought. They had more access to extension services, more cultivation and a higher disparity in cash income after the drought. It is argued that the different preconditions in Dida Hara and Web contributed to a lower use of mobility after the drought in Dida Hara than in Web.

Summarising the evidences of this sub-chapter, it was shown that the socio-economic profiles of Borana households favouring mobility were different for the period during and after the last drought. During the drought mobility was similar in Dida Hara and Web, as herd movements were driven by the crisis. The only clear trend was that households selling their animals at export markets were those which were most mobile. In the year after the drought, mobility was higher in Web than in Dida Hara. Mobility of households increased when they were part of larger herding groups and was higher for households with enough animals to live from livestock alone. Households with dromedaries were more mobile than others. These results suggest that in times of drought greater mobility is linked to households' access to livestock markets. In times of average rainfall greater mobility depends on location and is linked to larger herd size, to the capability of organising co-operative networks and to the adoption of dromedaries.

5.3.2 Relation of herd diversification to mobility

The households' herd diversification was tested in three forms, by the herd diversity index measured in TLU (SI household^{-1}), by the percentage of small ruminants and dromedaries measured in heads of livestock (n household^{-1}), as well as by the adoption of dromedaries. The situation before the start of the 1999/2001 drought was compared to the situation after the drought has passed[70]. The socio-economic determinants for herd diversity were tested for the two stages of drought (Table 17).

Table 17. Overview on measured and significant determinants compiled for herd diversity (SI in TLU), and of the proportion of heads of small ruminants and dromedaries (%), before and after the drought (Spearman Rhodes' rank-correlation and median test) (n = 60).

	--Total herd diversity-- (SI)		---Small ruminants--- (%)		---Dromedaries--- (%)	
	Before drought	After drought	Before drought	After drought	Before drought	After drought
Metric variable						
Herd size						0.286*
Ordinal variable						
Age head of household						
Consumption units						
Manpower						
Number of spouses						
Education						
Co-operation						0.263*
Livestock marketing				-0.296*		
Income diversification					-0.257*	
Cash income						
Nominal variable						
Location #	0.071°			0.004*	0.020*	
Human support capacity #			0.020*			
Adopt dromedaries #	0.045*	0.001*			0.000**	0.000**
Crop cultivation #				0.001*		0.007*
Equipment #						
Relief #						
Extension #						

= median test, others: rank-correlation.

Before the drought, herd diversity measured by the median of SI was for the majority of households in Dida Hara slightly higher than in Web (Table 17). This indicated that herds in Dida Hara were dominated by cattle, whereas herds in Web were slightly more diverse

[70] As has been outlined in chapter 5.2.1, the analysis of the household's herd diversity referred to the periods before and after the drought, whereas the analysis of the herd mobility referred to the periods during and after the drought.

(median test, $p<0.1$). After the drought, in Dida Hara the number of households above the median SI has been reduced, and in Web the number of households below the median SI has been reduced. As a result there was no difference in herd diversity between Dida Hara and Web (Table 18). The sign test confirmed, that drought has reduced the SI in Dida Hara, and indicates an increase in herd diversity after the drought (sign test, $p<0.05$). In Web no significant change in herd composition was recorded as the consequence of drought (compare Table 19). As a matter of fact, the adoption of dromedaries influenced significantly the SI.

Table 18. Means (SI in TLU) and standard errors (se) of herd diversity before and after the drought in Dida Hara and Web (n = 60).

	-------Dida Hara-------		----------Web----------		--------Average--------	
	Before drought	After drought	Before drought	After drought	Before drought	After drought
	----------[SI]----------					
Means	0.80	0.65	0.73	0.71	0.77	0.68
se	0.003	0.003	0.003	0.003	0.002	0.002

After the drought, only the adoption of dromedaries showed a significant correlation with the SI (Table 17). As no other of the hypothesised variables influenced a households' SI, the analysis of variance was not applied.

Yet, herd diversity measured by the proportional number of small ruminants and dromedaries complementary to cattle, revealed further socio-economic household characteristics (Table 17). Before the drought, the proportion of small ruminants was influenced by the human support capacity. Households below the human support capacity kept a comparatively higher share of small ruminants than households above the human support capacity (median test, $p<0.05$). After the drought, the proportion of small ruminants was negatively correlated to the livestock marketing (Spearman Rhodes' rank-correlation, $p<0.05$), it was higher in Dida Hara (median test, $p<0.05$), and it was higher for households with sufficient crop cultivation (median test, $p<0.05$).

The proportion of dromedaries before the drought was negatively correlated to income diversification (Spearman Rhodes' rank-correlation, $p<0.05$), and was more pronounced in Web (median test, $p<0.05$). After the drought, the proportion of dromedaries was positively correlated to herd size (Spearman Rhodes' rank-correlation, $p<0.05$), it was higher for households with access to bigger herding groups (Spearman Rhodes' rank-correlation, $p<0.05$), and for households with less crop cultivation (median test, $p<0.05$).

The sample locations Dida Hara and Web differed in the households' proportional herd

composition (Table 19). Before the drought, Dida Hara had a higher proportion of cattle ($p<0.1$), and Web a higher proportion of dromedaries ($p<0.05$). The effect of drought has reduced the proportion of cattle ($p<0.05$) and has increased the proportion of small ruminants in Dida Hara ($p<0.05$), but has not lead to notable changes in Web (sign test).

Table 19. Means (SI) and standard errors (se) of the proportion of heads of cattle, small ruminants and dromedaries before and after the drought in Dida Hara and Web (n = 60).

	-------Dida Hara --------		----------Web----------		----------Total----------	
	Before drought	After drought	Before drought	After drought	Before drought	After drought
	----------[SI]----------					
	Cattle					
Means	70	46	64	65	67	55
se	4.2	4.5	3.5	3.9	2.7	3.2
	Small ruminants					
Means	27	49	30	26	28	38
se	3.9	4.3	3.7	4.0	2.7	3.3
	Dromedaries					
Means	3	5	6	9	5	7
se	0.7	1.1	1.4	2.1	0.8	1.2

The variables of proportional herd composition were thus determined by different socio-economic characteristics before and after the drought. Notably, the influence of the location reconfirmed the findings of chapter 4.3 and chapter 5.3.1, that external interference has contributed to different applicability of IK.

The results further showed that more than 50 % of the Borana households kept dromedaries (AFigure 2), though drought has reduced the number of households with dromedaries significantly. The socio-economic characteristics of households keeping dromedaries was tested by logistic regression and verified by χ^2 test. Significant responses were found for the variables marked in Table 20.

Table 20. Overview compiled on measured and significant determinants of the adoption of dromedaries at household-level before and after the drought (n = 60).

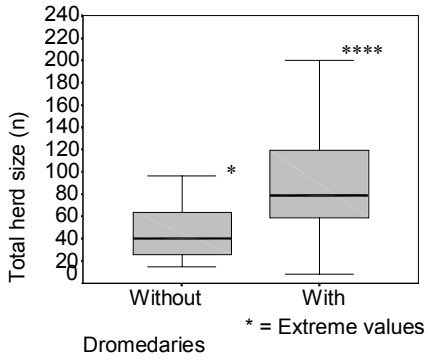
Household characteristics	------Before drought------		------After drought------	
	LOGISTIC REGRESSION	Median test / χ^2-sign.	LOGISTIC REGRESSION	Median test / χ^2-sign.
	Metric variable			
Herd size #	✓	0.001*		
	Ordinal variable			
Age of head of household	✓	0.098°		
Consumption units	✓	0.097°	✓	0.009*
Manpower				
Number of spouses				
Education	✓			
Co-operation				
Livestock marketing	✓			
Income diversification				
Cash income				
	Nominal variable			
Location				
Human Support Capacity	✓	0.004*		
Adopt dromedaries				
Crop cultivation				
Equipment			✓	0.001*
Relief				
Extension				

= median test, others: logistic regression;
✓ = selected variable by the logistic regression model.

Before the drought, the determinants for the adoption of dromedaries selected by the logistic regression model were herd size, consumption units, age of head of household, education, livestock marketing and human support capacity. Median test confirmed a significant influence by herd size and the χ^2 test confirmed a solid influence by the human support capacity. The influence of the consumption units and the age was weak, and the remaining variables did not show any significant influence. The frequencies of the socio-economic determinants in relation to the adoption of dromedaries before the drought are shown in Box 4.

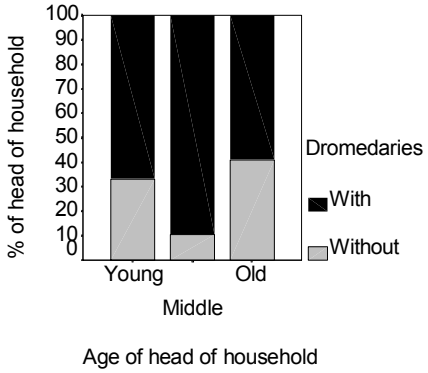
Herd size ($p<0.05$):

The mean herd size for households with dromedaries (mean 71, se 15) was bigger than for households without dromedaries (mean 23, se 3) (for median values compare the box-plot).



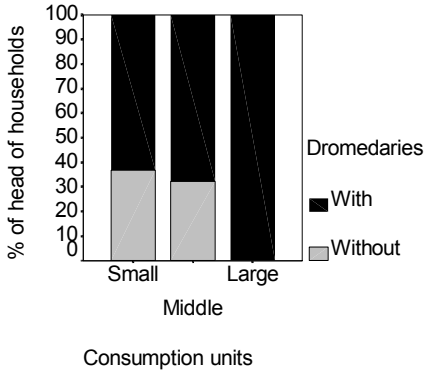
Age of head of household ($p<0.1$):

The age distribution was not in linear relation to the adoption of dromedaries. Nearly all medium aged head of households owned dromedaries (90%), while this was the case for 67% of young head of household and for only 59% of the elder head of household (compare diagram).



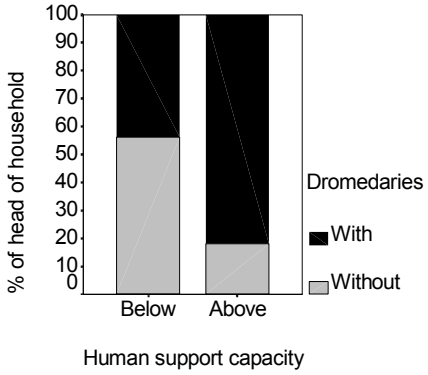
Consumption units ($p<0.1$):

The adoption rate of dromedaries increased with the consumption units. Large families adopted dromedaries by 100%, medium sized families by 68% and the small families by 63% (compare diagram).



Human support capacity ($p<0.05$):

Below the threshold for survival only 44% of the households adopted dromedaries, whereas above the threshold for survival 82% of the households kept at least one dromedary (compare diagram).



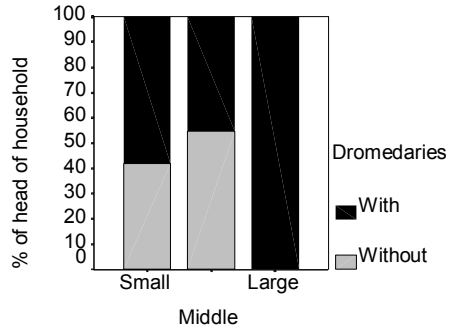
Box 4. Frequencies of socio-economic determinants for adoption of dromedaries before the drought (n = 60).

The logistic regression model for the adoption of dromedaries before the drought was delimited at the second stage of selection, with human support capacity and consumption units as the final explanatory variables (ABox 3). Only those variables were admitted to enter the model, which were confirmed by χ^2. It was accounted for the strong correlation between the human support capacity and the herd size, and the integration of further variables improved the prediction only slightly. The variable consumption units were not significant, but improved the cumulative response probability of the model. Integration of the two variables improved the prediction of the model significantly (Omnibus test, $p<0.001$) and enabled to predict 81.7% correctly. The goodness of fit of the model was good (Hosmer Leemeshow test significant at 0.977)[71]. The Nagelkerkes Pseudo R^2 (0.389) was sufficient.

After the drought, the determinants of the adoption of dromedaries selected by the logistic regression model were reduced to equipment and consumption units, and were confirmed by χ^2 (Box 5).

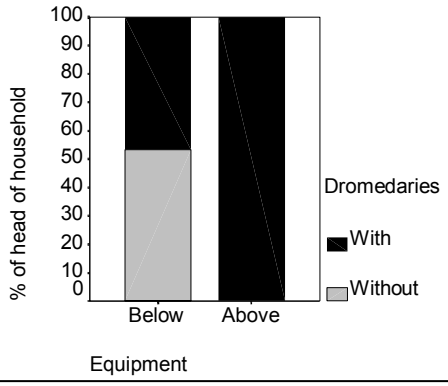
Consumption units ($p<0.05$):

Others to the situation before the drought, the adoption rate of dromedaries did not increase with the consumption units. Bigger consumption units adopted dromedaries by 100%, smaller by 58% and medium only by 45% (compare diagram).



Equipment ($p<0.05$):

Those households who disposed on sufficient equipment kept dromedaries by 100%, those without by 47% (compare diagram).



Box 5. Frequencies of socio-economic determinants for adoption of dromedaries after the drought (n = 60).

[71] A small value of significance suggests that the model is not adequate.

The logistic regression model for the adoption of dromedaries after the drought improved the prediction from 58.3% to 75.0% (Omnibus test, $p<0.000$, ABox 4). However, the parameter estimates were not adequate for predictions, as none of them was significant. The goodness of fit of the model was better than that for the time before the drought (Hosmer Leemeshow test significant at 1.000), and the results of both Pseudo R^2 (Cox and Snell = 0.359; Nagelkerkes = 0.483) were satisfactory.

Finally, testing the relationships among the dependant IK-variables - mobility, herd diversity and adoption of dromedaries - expectedly showed a significant correlation between herd diversity (SI) and the adoption of dromedaries (Spearman Rhodes' rank-correlation, $p<0.01$). No interrelationship was found between herd diversity and mobility, neither during nor after the drought. As has already been shown in chapter 5.3.2, the relation between mobility and the adoption of dromedaries was not significant during the drought, but became significant after the drought ($\chi^2 = 6.7$, $p<0.05$). After the drought, access to dromedaries has favoured households' mobility.

The evidences of this sub-chapter showed that herd diversification was influenced by different socio-economic household characteristics at the time before and after the drought. Before the drought, the adaptation of the herd's nutritional requirements differed between Dida Hara and Web. The proportional number of heads of livestock per household showed more cattle in Dida Hara and more dromedaries in Web, and this fits to the higher grazing potential in Dida Hara (compare chapter 4.3.4.1). The results further showed that households with more alternative sources of income kept comparatively less dromedaries, indicating a constraint in management capacity. After the drought, the dominance of cattle in Dida Hara was reduced and the proportion of heads of small ruminants became comparatively larger. Due to the high losses of cattle during the drought in Dida Hara small ruminants now played a comparatively greater role in the herds, although the forage resources for cattle were sufficiently available. The number of small ruminants was lower for households which sold their animals at bigger markets but was higher for those household who engaged in crop cultivation, suggesting that small ruminants were combined with more sedentary forms of land use and alternative income generation. Whereas the number of dromedaries was higher for households with larger herds and access to larger herding groups, and reflected pastoralists' efforts to maintain flexible herd management. The results further revealed that the households' general decision to keep dromedaries was also influenced by socio-economic criteria. Before the drought, households with larger herds were rather in a position to keep dromedaries. After the drought, households

with sufficient manpower and equipment were more likely to maintain dromedaries. This underlined that keeping dromedaries is a question of investment and management capacity. The effect of the sample locations was not significant for the decision to keep dromedaries, neither before nor after the drought. The testing for a relationship between the IK variables herd mobility and herd diversification did not show a complementarity, except that after the drought access to dromedaries favoured a households' mobility. Keeping dromedaries is therefore recommendable when to revitalise mobility in Borana rangelands.

5.3.3 Benefits from indigenous knowledge-based herd management

The effects of the key variables herd mobility and herd diversification were tested on benefits for the households' herd management, using the indicators of low mortality rate during the last drought year and a high net herd growth rate during the first year after the drought. The descriptive statistics on pastoralists' information (A13 in ATable 1) about the herd outflows during the drought showed mean mortality rates of 54% for cattle, 29% for small ruminants and 30% for dromedaries (ATable 28). The information about the herd inflows after the drought resulted in mean net herd growth rates of 27% for cattle, 15% for small ruminants and 13% for dromedaries.

The mortality rate of cattle during the last drought year was influenced by herd diversity (F-test, $p<0.01$, Table 21). The effect of herd diversity explained maximal a third of the variance in the mortality of cattle, when the IK-variables and interrelationships were involved. The remaining variance was determined by factors not included in the analysis. Cross-check with Pearson's correlation confirmed the linear relationship between herd diversity and the mortality of cattle (correlation regression coefficient 0.479, $p <0.01$). Lowess regression confirmed the trend of a reduced mortality when diversity was higher. The mortality rate of small ruminants and of dromedaries could not be explained by any of the IK-variables.

Table 21. Analysis of variance referred to the mortality rate of cattle (%) during the drought (n = 60).

Source of variance	df	Mean square	F	Significance
Corrected Model	6	0.136	4.239	0.001
Constant term	1	8.739E-6	0.000	0.987
Herd diversity	1	0.549	17.090	0.000
Mobility	2	0.067	2.076	0.136
Adopt dromedaries	1	0.007	0.228	0.635
Mobility * adopt dromedaries	2	0.001	0.042	0.958
Error	53	0.032		
Total	60			

$R^2 = 0.324$ (corrected $R^2 = 0.248$)

The net herd growth rate of cattle during the first year after the drought was affected by mobility ($p<0.05$), the adoption of dromedaries ($p<0.05$) and the interrelationship between the two (F-test, $p<0.01$, Table 22). Cross-check by Pearsson's correlation confirmed a negative linear relation between the net herd growth of cattle and mobility (correlation regression coefficient -0.418, $p<0.01$), but none was found for the adoption of dromedaries. Nevertheless, the effect of mobility, herd diversity and the interrelationship between mobility and the adoption of dromedaries explained about two thirds of the variance in the net herd growth of cattle.

Table 22. Analysis of variance referred to the net herd growth rate of cattle (%) after the drought (n = 60).

Source of variance	df	Mean square	F	Significance
Corrected model	9	1.849	9.212	0.000
Constant term	1	0.878	4.375	0.042
Herd diversity	1	0.073	0.365	0.549
Mobility	2	0.828	4.127	0.023
Adopt dromedaries	1	1.371	6.833	0.012
Mobility * adopt dromedaries	2	3.237	16.129	0.000
Mobility* herd diversity	2	0.265	1.320	0.278
Adopt dromedaries * herd diversity	1	0.427	2.128	0.152
Error	43	0.201		
Total	53			

$R^2 = 0.658$ (corrected $R^2 = 0.587$)

Table 23 shows the declining means in net herd growth rate of cattle with higher levels of mobility, and a more negative net herd growth when dromedaries have been adopted. The strong interrelationship between mobility and the adoption of dromedaries explains the irregularities of the means within the estimated parameters.

Table 23. Means (%) and standard deviations (sd) of the net herd growth rate of cattle after the drought associated with ranks of mobility and adoption of dromedaries (n = 60).

Mobility	Adopt dromedaries	Means (%)	sd	n
Low mobility	Without dromedaries	-0.05	0.54	18
	With dromedaries	-0.26	0.41	13
	Total	-0.14	0.50	31
Medium mobility	Without dromedaries	-2.13	0.17	2
	With dromedaries	-0.39	0.37	14
	Total	-0.61	0.69	16
High mobility	Without dromedaries	-2.76	-	1
	With dromedaries	-0.92	0.51	6
	Total	-1.22	0.88	5
Total	Without dromedaries	-0.38	0.97	21
	With dromedaries	-0.42	0.46	32
	Total	-0.40	0.70	53

The net herd growth rate of dromedaries was also affected by mobility (F-test, $p<0.05$, Table 24), and Pearsson's correlation confirmed a negative linear relationship (correlation regression coefficient -0.394, $p<0.05$). The effect of mobility explained only about one fifth of the variance in the net herd growth of dromedaries.

Table 24. Analysis of variance referred to the net herd growth rate of dromedaries (%) after the drought (n = 60).

Source of variance	df	Mean square	F	Significance
Corrected model	5	0.199	1.568	0.200
Constant term	1	0.057	0.450	0.508
Herd diversity	1	0.167	1.321	0.260
Mobility	2	0.444	3.505	0.043
Adopt dromedaries	1	0.012	0.098	0.757
Mobility * adopt dromedaries	1	0.079	0.624	0.436
Error	29	0.127		
Total	35			

$R^2 = 0.213$ (corrected $R^2 = 0.077$)

Table 25 shows the declining means in net herd growth rate of dromedaries with higher levels of mobility.

Table 25. Means (%) and standard deviations (sd) of the net herd growth rate of dromedaries after the drought associated with ranks of mobility (n = 60).

Mobility	Means (%)	sd
Low mobility	0.26	0.36
Medium mobility	0.09	0.29
High mobility	-0.19	0.48
Total	0.12	0.37

The net herd growth of small ruminants did not show a significant relation to any of the IK-variables.

The explanation of successful herd management was further investigated by testing the effects of the socio-economic household characteristics on the mortality rate during the last drought and the net herd growth rate of cattle, small ruminants and dromedaries after the drought has passed (Table 26).

Table 26. Overview on measured and significant socio-economic determinants of mortality rates during the drought (%) and net herd growth rates after the drought (%) of cattle, small ruminants and dromedaries (Spearman Rhodes' rank-correlation and median test) (n = 60).

	----------Mortality rates --------			----Net herd growth rates----		
	Cattle	Small ruminants	Drome-daries	Cattle	Small ruminants	Drome-daries
Metric variable						
Herd size				-0.404**		
Ordinal variable						
Age head household						
Consumption units					0.342*	
Manpower					0.315*	
Number of spouses						
Education					0.488**	
Co-operation						
Livestock marketing				-0.283*		
Income diversification						
Cash income				-0.391**		
Nominal variable						
Location (#)	0.002*	0.001*	0.048*	0.000**		0.004*
Human support capacity (#)						
Adopt dromedaries (#)		0.050°				
Crop cultivation (#)						
Equipment (#)						
Relief (#)						
Extension (#)						

(#) = median test, rest rank-correlation.

The sample locations Dida Hara and Web showed differences in the mortality rate of cattle ($p<0.05$), small ruminants ($p<0.05$) and dromedaries ($p<0.05$) (median test, Table 26). The T-tests revealed, that the mortality of cattle was significantly higher in Dida Hara than in Web ($p<0.05$), whereas the mortality of small ruminants and of dromedaries was significantly higher in Web ($p<0.01$ and $p<0.05$ respectively) (Table 27). Outflows others than mortality, they were sales. In Dida Hara, the sale rate of cattle was only about a quarter of the mortality rate, the sale rate of small ruminants was about a double of the mortality rate, and sale rate of dromedaries was similar to the mortality rate (ATable 29). In Web, the sale rate of cattle was similar to that in Dida Hara and the sale rate of small ruminants and of dromedaries was less. The losses of livestock due to the drought were significant for all species at both locations (sign test, $p<0.01$).

Table 27. Means (%), standard errors (se) and significant differences of mortality rates associated with cattle, small ruminants and dromedaries during the drought in Dida Hara and Web (n = 60).

		Means (%)	se	T-test - sign.
Cattle	Dida Hara	0.60	0.38	0.017
	Web	0.47	0.34	
Small ruminants	Dida Hara	0.15	0.34	0.000
	Web	0.44	0.60	
Dromedaries	Dida Hara	0.20	0.70	0.044
	Web	0.40	0.64	

Table 28 further explains that the losses of livestock and the losses of cattle were higher in Dida Hara in absolute numbers. Web, with smaller herds before the drought, had higher losses when measured as share of the herds. The losses in small ruminants and dromedaries were higher in Web, absolutely and proportionally.

Table 28. Means (heads) and standard errors (se) of the number of cattle, small ruminants and dromedaries before and after the drought in Dida Hara and Web (n = 60).

	----------Dida Hara---------			----------Web----------			----------Average----------		
	Before drought	After drought	Diffe-rence (%)	Before drought	After drought	Diffe-rence (%)	Before drought	After drought	Diffe-rence (%)
	----------[heads]----------								
	Cattle								
Means	99	41	-58 (-59)	45	15	-30 (-66)	73	28	-45 (-61)
se	28.7	18.8	-9.9	4.5	2.1	-2.4	15	9.8	-5.4
	Small ruminants								
Means n	29	19	-10 (-34)	24	8	-16 (-66)	27	14	13 (-48)
se	6.6	5.1	-1.5	4.9	1.8	-3.1	4.1	2.9	-1.3
	Dromedaries								
Means	4	2	-2 (-37)	4	2	-2 (-47)	4	2	-2 (-42)
se	1.1	1.0	-0.2	0.7	0.4	-0.3	0.7	0.5	-0.2

The mortality rate of small ruminants was further influenced by the adoption of dromedaries (Table 26), indicating that small ruminant mortality was lower for households without dromedaries (median test, $p<0.05$).

Addressing the net herd growth rates, the results in Table 26 showed a strong negative correlation between the net herd growth of cattle with the total herd size and the cash income (Spearman Rhodes' rank-correlation, $p<0.01$). This indicates a lower rehabilitation of the herds after the drought at higher levels of wealth. On the other hand, the effect of the locations indicated a lower net herd growth in Web, the location with the lower levels of wealth (median test, $p<0.01$). Furthermore, the net herd growth of cattle was negatively correlated to

livestock marketing (Spearman Rhodes' rank-correlation, $p<0.05$). The latter can be interpreted for ongoing emergency sales after drought, which impinged negatively on the herds' regeneration from drought. The net herd growth of small ruminants thereof was strongly correlated to education (Spearman Rhodes' rank-correlation, $p<0.01$), and was also correlated to consumption units and manpower (Spearman Rhodes' rank-correlation, $p<0.05$). Keeping small ruminants seemed fitting with schooling, being easily converted to the different needs of the household members, and requesting sufficiently available manpower. The net herd growth of dromedaries showed a relation only to the location, and confirmed the lower net herd growth of dromedaries in Web (median test, $p<0.01$).

The sample locations revealed differences also in the net herd growth rates, being higher for cattle and dromedaries in Dida Hara than in Web (T-test, $p<0.01$ and $p<0.05$ respectively, Table 29). In Dida Hara, major inflows of cattle and dromedaries were births, followed by gifts due to NGO's restocking programmes and only few purchases occurred (ATable 30). The outflows after the drought were dominated by sale of cattle. For small ruminants sale, transfer out and death were similar. Minor outflows were counted for dromedaries (ATable 29). Interesting to note, that the death of small ruminants was higher in Dida Hara after the drought, and many cases of imported diseases were reported from the restocking programmes (A12, A13 in ATable 1). In comparison, Web had a lower birth rate for all livestock species and gifts were almost not existent. The outflows in Web were comparatively higher, with a sale of cattle double than that in Dida Hara, and a much higher sale of dromedaries. The lower birth rates combined with higher sales of livestock reflected the problem of the ongoing distress in Web after the drought.

Table 29. Means (%), standard errors (se) and significant differences of net herd growth rates associated with cattle, small ruminants and dromedaries after the drought in Dida Hara and Web (n = 60).

		Means (%)	se	T-test - sign.
Cattle	Dida Hara	0.57	0.11	0.000
	Web	0.00	0.60	
Small ruminants	Dida Hara	0.19	0.13	n.s.
	Web	1.00	0.11	
Dromedaries	Dida Hara	0.28	0.70	0.009
	Web	0.00	0.90	

The evidences of this chapter challenged the assumption that applied IK-based range management strategies favour successful herd management. Testing the effects of the IK variables on the mortality rates and net herd growth rates showed that mobility did not prevent the high mortality of cattle, small ruminants or dromedaries during the drought. Herd

diversification only has contributed to reduce the mortality of cattle. Instead, mobility had a negative impact on the net herd growth of cattle after the drought, being aggravated for households who kept dromedaries. Mobility was also negative to the net herd growth of dromedaries. The mortality rate of dromedaries and the herd dynamics of small ruminants could not be explained by any of the IK variables, and must be due to other factors. Furthermore, it was tested whether the socio-economic household characteristics had an effect on the mortality rates and the net herd growth rates. The results showed that notably the sample locations Dida Hara and Web caused differences in the herd dynamics and thereby they give another evidence for the different potentials to make use of IK.

5.4 DISCUSSION

5.4.1 Data characteristics and interpretation

This chapter determined the socio-economic characteristics of those households who use the pastoral key strategies herd mobility and herd diversification in the Borana rangelands. The definition of Borana pastoralists' IK based rangeland management strategies and testing them against locally defined socio-economic household characteristics was expected to provide deeper information on the Borana pastoralists' adaptation to changing frame conditions. Measuring currently applied range management strategies complements the historical view on the disturbances to the Borana pastoral management system (compare chapter 4). The case study, thereby, improves the understanding, how socio-economic together with ecological factors explain the viability of pastoral management systems under pressure.

Mobility as the dependent variable was analysed by ordinal regression, implying the conversion of metric distances in movements into ranks of mobility. Arbitrary demarcation of the thresholds for the ranks of mobility instead of measured distances of movements (km) might be an argument against the procedure. However, the pastoralists' local weighting factors have shown that mobility is not a constant variable. Not only the distance of herd movements matter but also moving at least the cattle herd, and the frequency of shifting the herds. Behind this background, the ordinal regression procedure provides an explanatory tool to test the existence of relationships between socio-economic factors and the locally perceived standard of a households' mobility. It allows predicting gradual reduction in mobility caused by socio-economic change, and hence concretising future development measures to prevent this. In agreement with Smith *et al*. (2001) using ranks of mobility also bears the advantage of illustrating probable trends, rather than loosing information in extremely small differences.

The analysis of herd diversification showed trends in combining cattle with small ruminants and dromedaries. Analysis of variance was used to test socio-economic influences on the percentages of cattle, small ruminants and dromedaries in the herds. The indicators for herd diversity (SI and heads of small ruminants and dromedaries household^{-1}) reflected nutritional and management parameter, but could not account for the cultural value pastoralists attribute to the different species. As referred in chapter 4.4 the study was further limited to measure herd diversification by species diversity, but could not address the diversification within the herds. However, measuring herd diversity by percentages of livestock species and conversion into livestock equivalents provides useful information about local ecological and socio-economic trends. The question what type of households adopted dromedaries was partly explained by the socio-economic determinants. But other factors such as the individual attitude towards dromedaries, experience and management skills for dromedary husbandry certainly have an influence.

Against this background, the study provides solid evidences to support the hypothesis that in the Borana rangelands, socio-economic household characteristics determine the application of mobility as the key strategy of IK-based range management. Although not all the socio-economic determinants tested were confirmed, the marketing variable influenced the applied mobility during the drought, and a set of characteristics influenced the mobility after the drought. Drought as another determinant of mobility caused temporarily different adaptations in the use of the available forage and water resources. This confirms the fact that during a drought movements are driven by crisis, whereas years of average rainfalls and lower stocking densities allow for more regular movement patterns. The differences in the distribution of socio-economic household characteristics between the locations Dida Hara and Web confirms once more the hypothesis of the previous chapter, that the external interventions manifest themselves in different predisposition for applied IK. In other words, the pastoralists nowadays practice less mobility, they are poorer, and social differences grow (compare chapter 4.3).

The evidences for the hypothesis that socio-economic household characteristics determine herd diversification are rather weak. Among the several indicators, the herd diversity index (SI) was only significant for the variable location before the drought, stressing the role of natural heterogeneity for adaptive herd management and the impact of development interventions thereupon (compare chapter 4.3). When dissecting herd diversity as the percentages of small ruminants and dromedaries separately, this revealed further socio-

economic influences. The role of drought was also reconfirmed as a factor for the changes in herd composition. The adoption of dromedaries was influenced by certain socio-economic characteristics before and after the drought, but the prediction was relatively low. The benefits from applied IK showed a strong influence of the location for almost all livestock species. This supports the argument, that in Dida Hara and Web, locations which were formerly integrated in extended range management systems, different potentials and constraints for applied IK emerge. In conclusion, therefore, the hypothesis that there are socio-economic household characteristics which affect the application of Borana pastoralists' IK-based range management strategies is accepted. This refers mainly to mobility, to a lesser degree also to herd diversification.

5.4.2 Utilisation of herd mobility

The determinants of mobility as the prime IK-based range management strategy indicate different priorities to exploit the variable natural resource supply in years of sufficiently available forage and water, and to improve flexibility during droughts. According to the regression model of mobility during the drought, access to livestock markets is most essential. Although the computed pseudo R^2 was small, and only one individual coefficient was statistically significant, the model expressed a priority for economic flexibility under high risk. The parameter estimation of the marketing variable expressed high importance of the export market Moyale, which according to Teka *et al.* (1999) is known for high non-official livestock trade. Behnke (1987) showed that subsistence livestock farmers are more tightly involved in the economic transfer of livestock than it had been assumed. Livestock markets are an obvious means by which pastoralists seek to achieve a rapid transfer-out of livestock when the resources to feed the herds are exhausted. They are also an important centre for timely information transfer and acute planning of drought coping strategies. The results further revealed that the export markets can alleviate heavy grazing pressure during droughts more than the local markets. This supports the argument that under increasing population densities and rangeland degradation the need to sustain herders' flexibility becomes more pressing and livestock market development becomes most important. A critical task will be to act on the distributional consequences of markets, without increasing the economic vulnerability of the poor (Sikana *et al*., 1993; Holzman and Kulibaba, 1995; Turner and

Williams, 2002)[72].

The regression model of mobility after the drought, a situation with better forage and water supply, selected the variables co-operation, location, and human support capacity as most essential. Co-operation among households for moving the herds becomes indispensable for those pastoralists who maintain a herd size above the human support capacity, and differs between Dida Hara and Web. The predictability of the model has improved compared to that of mobility during the drought, with pseudo R^2 above 0.5, and three coefficients being statistically significant. The model indicated that after the drought, the Borana pastoralists' re-organise their technological capacities to adjust the herds better to the temporary favourable forage resources. As it has been explained by other authors, that the households' co-operation improves the efficiency of mobility, involving labour pooling and information sharing, and reinforcing reciprocity arrangements (Swallow, 1994; Niamir-Fuller and Turner, 1999). However, as it was observed at the study sites, sedentarisation and the commercialisation of the livestock husbandry contribute to an individualisation in many pastoral societies in East Africa, and limit co-operation (Fratkin, 1997). The example of Dida Hara corresponds very well to the findings of Kamara (2001) and McCarthy *et al.* (2001) that non-co-operation expands particularly in communities with many households and a high socio-economic heterogeneity. Thus, identifying households who can afford mobility and facilitating structures for co-operation in herd mobility is of high priority for efforts in sustainable rangeland development.

The selected variables in the different stages of drought underline the important role of the classical co-operative herd mobility, to be combined with modern livestock marketing for low income pastoral systems as in Borana. The combination of the two strategies improves the local opportunities to adjust livestock demand to the variable forage and water supply. The Borana pastoralists stick to the key principles of pastoral persistence: exploiting non-equilibrium resources during years of abundant rainfall and maintaining access to external resources during periods of stress (Ellis *et al.*, 1993). They follow the opportunistic range management described by Sandford (1983), and apply different techniques for tracking forage and water resources in space and time as observed by Scoones (1995) and Illius *et al* (1998).

[72] Impoverishment is often accelerated through the correlation of environmental and market risk, reflected in negative terms of trade against livestock products.

The results further stress the fact that in pastoral systems like the Borana, droughts alter the pattern of mobility and the influence of socio-economic determinants. As measured by Ndikumana *et al*. (2000) and confirmed in chapter 4.3.1, droughts expand the distance of movements for an intensified search of resources to survive. This was also reflected in a better predictability of the after-drought regression model. The models confirmed that herd movements become more hazardous when driven by scarcity, and that they follow more regular patterns when forage and water resources are sufficiently available. These observations are in accordance with the findings of Niamir (1990) and Niamir-Fuller and Turner (1999). In this context, the identified determinants of mobility in the periods during and after the drought accentuate different support strategies for IK-based rangeland management. Taking these findings into account, pastoral IK-based development concepts should be planned from a drought perspective. As Coppock (1994) argued, during droughts the operations may be limited to subsidiary mechanisms for short term flexibility in order to facilitate the transfer-out of livestock by marketing. Whereas, after droughts, the support focus must be directed to rehabilitation of the herd and re-organisation of co-operative herd movements.

The results further revealed that droughts reduce the households' ability to apply mobility and thereby aggravate non-sustainable rangeland utilisation. Droughts accelerate the drop of households below the threshold for survival, and thereby reduce the number of households who can apply mobility. It is argued here, that the emergency conditions force many households to seek for alternative income. As was explained by the pastoralists (compare chapter 4.3.3.4 and 4.4), lack of alternative options, poor households engage primarily in crop cultivation, which is known as counterproductive to pastoral land use and blocks the frequency and distance of movements. The emerging antagonistic land use objectives create structural disagreements within the Borana pastoral society. These arguments support Morton and Meadows (2000), drawing attention on the different adaptive strategies between poorer and wealthier households. Poor pastoralists are forced to secure their food availability under stress, and thereby risk acting against sustainable livelihoods. Whereas, wealthy pastoralists can diversify into livelihoods, that are complementary to pastoral production. As Sandford and Habtu (2000) pointed out, subsidiary income sources need to be developed, to absorb impoverished households from the dependence on livestock, without destroying their socio-cultural embedding. This study further suggests that the owners of large herds are to be addressed with incentives for transfer of heads of livestock in investments complementary to pastoral livestock production, such as transport and marketing facilities, local slaughter

houses, meat and milk processing. Strengthening the local linkages between livestock production, marketing and processing can enhance the individual flexibility of small-scale herd owners as well as large-scale producers. This can also contribute to the development of local structures for rehabilitation from droughts (Blench, 2001). In agreement with the findings of McCarthy (1998) and Kamara (2001), the preservation of mobility in the Borana system will crucially depend on measurements directed at socio-economic stability, and the mitigation of the effects of drought.

The different distribution of mobility and of socio-economic household characteristics in Dida Hara and Web confirm the fact that the external interventions have created differences in IK at disposition. After the drought, the mobility in Web was still pronounced along with better co-operation. In Dida Hara, the mobility was low, access to extension service as well as crop cultivation above 1.5 ha land more frequent, and the distribution of cash income was more heterogeneous. Web seems more predestined to maintain the co-operative IK-based mobility, whereas Dida Hara seems more susceptible to abandon mobility, and as explained below more households in Dida Hara have to invest in livelihoods others than livestock. These findings add to the argument in chapter 4.4 that despite better pasture conditions in Dida Hara, pastoralists in Web are in better position to make more judicious use of the grazing resources. External interference thus induces different potentials among locations to adapt to changing ecological and socio-economic frame conditions.

5.4.3 Utilisation of herd diversification

The second IK-based range management strategy - diversification of herds with proportionally more browsers – was assumed as a gradual adaptation to changes in the available vegetation, supplementary to mobility and therefore driven by socio-economic factors. Herd diversity under nutritional considerations and measured by the Simpson Index revealed only the location as influential before the drought. The different conditions in Dida Hara resulted in more cattle-dominated herds before the drought, but this difference disappeared after the heavy losses of cattle during drought and thereby a comparatively high share of small ruminants after the drought. Higher proportions of cattle in Dida Hara are appropriate in terms forage supply, in so far as Dalle (2004) has found a higher grass bio-mass production in Dida Hara, and less woody species encroachment than in Web (compare chapter 4.3.4.1). One can also argue that the higher proportions of dromedaries in Web before the drought were appropriate to make better use of the available vegetation. The different herd composition in Dida Hara and Web before the drought thus reflects the Borana pastoralists'

efforts in adapting the needs of the herds to the locally available grazing resources. Whereas, the results showed that after the drought, the share of small ruminants became predominant in Dida Hara, despite sufficiently available grassland resources. This trend is interpreted as a sign of distress due to the drought and not merely as a purposeful adaptation to the ecological environment.

The process of variable herd composition was further measured in terms of management requirements for the proportional share of small ruminants and dromedaries. The share of small ruminants and dromedaries showed different influences by socio-economic factors, and depending on the stages of drought. Small ruminants, before the drought, were more frequent in herds below the human support capacity. After the drought, they were more frequent in Dida Hara and in households with less marketing and sufficient crop cultivation. Keeping more small ruminants indicates a trend for a more sedentary way of life combined with livelihood strategies others than livestock. Examples of neighbouring pastoral societies confirm shifts towards small ruminants as the most appropriate strategy for impoverished herd owners to maximise survival chances. Small ruminants show a better drought resistance than cattle. The herds with small ruminants recover faster after drought. They need less manpower, they can be kept stationary and in combination with crop cultivation or other alternative forms of income generation and they make better use of the locally available vegetation. Disadvantageous is their high susceptibility to diseases (Mace and Houston, 1989; Roth and Fratkin, 1991; de Leeuw and Reid, 1995).

The share of dromedaries before the drought was higher in Web than in Dida Hara. Mainly households with few alternative income sources to pastoral production kept more dromedaries. After the drought, more dromedaries were kept in households with less crop cultivation and co-operation in larger herding groups. Keeping more dromedaries indicates another trend to maintain flexible herd management based on mobile livestock production. Dromedaries were known (A9 in ATable1) to be advantageous in drought resistance and walking ability compared to cattle, what enable them to use a larger inventory of forage resources. Their high supply of milk can improve the nutritional situation of pastoral households effectively. However, dromedaries are slowest in reproduction. They request the highest investment costs and are more susceptible to diseases and parasites than the other ruminants (Kaufmann, 1998).

The households' decisions to keep dromedaries depend on different socio-economic determinants and the stages of drought. Before the drought, sufficiently large herds were

essential. After the drought, keeping dromedaries was found mostly in large households with a minimum of equipment. The results confirm the assumption, that keeping dromedaries is a question of economic means. Households who can afford dromedaries increase flexibility in herd management and extend the functional and real value of their herds. Borana pastoralists explained (A9 in ATable 1) that providing transport dromedaries enable households to split-off a mobile unit, and with a more reliable milk supply they improve food security for the sedentary unit. However, households with dromedaries act not congruent to the cattle centred tradition of the Borana pastoralists. Unlike with cattle, cultural integration of dromedaries in rituals and ceremonies is not common and their utility is seen controversial among experts (A15 in ATable 1). The Borana have started experimenting with dromedaries in the 1970s. The number of households who adopted dromedaries increased in the beginning 1990s, after heavy droughts, inter-ethnical conflicts and an ongoing degradation of rangeland conditions, and flawed down in the late 1990s. Still, the skills on dromedary husbandry are scarce among Borana pastoralists, especially in terms of disease prevention and herding management. This is reflected in comparatively low productivity (compare chapter 4.3.4.2) and it also contributes to the fact that the number of household who kept dromedaries has been reduced after the last drought. For pastoral systems such as the Borana, the investment in dromedaries can be interpreted as an indicator for rangeland degradation and as an adaptive strategy to improve survival. Therefore, dromedaries in the Borana rangelands indicate pastoralists' efforts for a pragmatic compromise, whereas keeping cattle stands for high quality production which is endangered by degradation.

5.4.4 Trends of indigenous knowledge-based range management strategies

Exploring the relationship between the IK-variables showed different responses according to the drought stage. During the drought, management strategies of the Borana herders were extremely variable. A relationship between the investigated IK-variables was not found, what confirmed that in times of scarcity the pastoralists act speculative. After the drought, the adoption of dromedaries supported a household's decision for herd mobility. Most households who had adopted dromedary husbandry were in consequence more mobile. The adoption of dromedaries thus became an important endogenous adaptation of pastoral production strategies to the changing environment. For those the basis of IK is strengthened. However, an increase in the number of dromedaries per household does not necessarily lead to higher mobility.

The results show, that the formerly cattle centred production of the Borana pastoralists has

transformed into different multi-species systems in response to local ecological and socio-economic changes. Cattle still play a dominant role in the Borana pastoral systems, but dromedaries beared up importance within a short period of time, and it is anticipated that the role of small ruminants will increase especially for the poor and sedentarised households. The observations further confirm that IK-based range management is highly specific to locality, with different potentials for herd diversification. Neighbouring pastoral livestock systems have also changed their herd composition according to diverting production goals. Roth and Fratkin (1994) observed a recent emphasis on cattle instead of dromedaries in the Rendille herds by wealthy households starting with commercial production. The many poor households, in contrast, shifted towards small ruminants. Examples from the Somali (Abdullahi, 1993), or the Massai (King *et al*., 1984; Bekure *et al.,* 1991) attest more concentration on small ruminants, as a result of the degrading habitat and the impoverishment of the population. From the pastoralists' perspective, herd diversification is an appropriate response to the changing production conditions. This enables them for more intensive exploitation of the available forage resources. But an important question is how the emerging livestock systems in turn affect the socio-economic stability in rangelands such as the Borana.

In the Borana rangelands, the currently applied IK-based range management strategies are no longer embedded in extended social structures, interacting with the ecological landscape. Instead, different adaptations to the changing conditions in Dida Hara and Web risk exacerbating disturbances to the Borana land use system. In Dida Hara, the socio-economic heterogeneity grows within the communities and triggers polarisation among the individual households (compare chapter 4.3.3). Households are more susceptible to drought, even though access to innovation is closer through the available extension service and the proximity to urban centres. The majority of herd owners adjust herd management towards sedentarisation and auxiliary livestock production. Only a minority seems able to maintain a mobility based cattle husbandry. These better-off herd owners enter into commercial livestock production and assuring their economic superiority. In Web, most pastoralists continue with a subsistence production and a limited herd size, sustained by mobile land use and a minimum of dromedaries. The study has shown many signs for an increase in social differentiation within the Borana society, an over-utilisation of key pastures and presumably under-utilisation of remote grazing land. Consequence is an uneven and not appropriate exploitation of natural resources, further reducing the flexible utilisation of rangelands. Similar trends of fragmenting formerly interdependent grazing zones have been observed world-wide. There is evidence, that this has negative consequences for the ecological functioning of the extensive grazing

systems, as well as on the social structures (de Ridder and Wagenaar, 1984; Blench, 2001; Ash *et al*., 2003).

5.4.5 Trends of herd dynamics

Although the benefits from livestock production are determined by multifaceted natural and socio-economic factors, the different land use scenarios in Dida Hara and Web clearly had an impact on the current mortaliy rates and the net herd growth rates (Table 26). The total economic damage caused by the drought was higher in Dida Hara than in Web. The findings of this study confirmed the official statistics of ODPPB (2000) that the highest absolute mortality rate of cattle in the Borana rangelands occurred in Dida Hara, and they exceeded the high mortality of browsers in Web (Table 27; ATable 29). Of all variables tested on their effect on the mortality of cattle, only herd diversification was significant in reducing the mortality (Table 21), being less in Dida Hara. Households with alternative livestock do not need to extract so many products from cattle, and can balance their subsistence needs and the drought resistance from different species. The pastoralists reported that the increased and permanent stocking densities combined with a long distance to the remaining water places have caused the crash of the cattle population in Dida Hara. Sedentary and cattle dominated locations such as Dida Hara thus face particular difficulties during droughts, although the total stocking density is lower than in Web and despite the ongoing development interventions. In agreement with Copolillo (2000) it is further suggested that herds which are dominated by lactating cows are unlikely to mitigate long distances, compared to steers, which can lower their metabolism. However, the decimated herds of the Borana limit the potential for herd splitting.

The mortality rates of goats and dromedaries could not be explained by any of the measured household parameters. For small ruminants and for dromedaries the mortality rates were comparatively high, but corresponded to the official counts (ODPPB, 2000). The narratives from the pastoralists provided an explanation by natural factors, as the bio-climate in Web (*finna*) was seen as excellent for cattle, but less suitable for small ruminants. High susceptibility to diseases, lack of accessible veterinary products and insufficient experience in medical care of dromedaries are considered as the further reasons.

The drought-induced distress on the herds, however, persisted longer in Web than in Dida Hara. The net herd growth rates of cattle and dromedaries during the first year after the drought remained zero in Web, whereas in Dida Hara they reached 57% and 28%

respectively. Households in Web continued selling 30% of their remaining cattle and 9% of their dromedaries to meet their subsistence needs, compared to Dida Hara of about 16% and 0% respectively. Additionally, the birth rates for cattle (35%) and dromedaries (14%) were less in Web, compared to Dida Hara with 59% and 31% respectively (ATable 30). The negative trends in net herd growth of cattle and dromedaries are partially explained by higher mobility (Table 22; Table 24). In Web, rainy-season forage was less available and combined with high mobility this delayed the recovery of the herds. Moreover, households in Web were not approved for restocking measurements by NGO's. No other inflows occurred because surplus of cash for reinvestment in livestock was not available. Thus, the former rainy-season area Dida Hara turned out advantageous for drought recovery, whereas households in Web faced a shortage in pasture.

Moreover, it was found that different indicators for wealth had negative impact on the net herd growth rates of cattle (Table 26). Households with access to more capital and probably stronger bargaining power not necessarily invest more in the recovery of their herds than poor households. The few wealthy herd owners in Dida Hara sold large numbers of cattle after the drought. They invested in restocking, buying heifers at comparatively low price, and in non-pastoral sources of income. As a result, the net herd growth of wealthy households seemed low, but their economic superiority was certainly secured. These observations confirmed an important notion, that wealth influences the households' potential for recovery after a drought (Little, 1985; Herren, 1988). They add to the conclusions of authors like Sieff (1999), saying that wealthy households manage to retain more livestock during droughts, selling cattle in better condition and at better markets, and thereby fetching higher prices per animal. The owners of small cattle herds, in contrast, are continuously forced to sell cattle and at the same time to extract more milk per cow of the remaining animals. The result is de facto a stronger over-exploitation of their herd. Owners of only small herds become during droughts more and more vulnerable (Bekure *et al.,* 1991). The gap between different strata of wealth is increasing, even though this might not be reflected in the net herd growth of cattle.

The net herd growth of small ruminants in comparison was strongly correlated to the level of education, irrespective of wealth or location (Table 26). Small ruminants seem to be useful especially for households who invest in the future generation of alternative forms of income. The positive influence of a larger household size on the net herd growth of small ruminants signalises the need of sufficient labour for their careful herd management.

What conclusions can be drawn concerning the benefits of Borana pastoralists' IK at the

household-level? The case study revealed that under increasing scarcity of rangeland resources, herd diversification is beneficiary to buffer drought induced herd losses. In contrast, mobility does not improve the ability to cope with droughts, and is negative for the recovery of herds after droughts. Taking into account the conclusions from chapter 4, disturbances which ignore pastoralists' IK further reduce the economic benefits from applied IK. Socio-economic factors evolve which mediate further differentiation to the local land use scenarios, and probably enhance the erosion of pastoral IK.

6 CONCLUSIONS

In the past Borana pastoralists were in a favourable position to develop a complex range management system. The concentrated sources of permanent water and sufficient productive pastures in the periphery fostered the regular co-ordination of herd movements. The mobile range use pattern sustained precise arrangements for temporary range utilisation and maintenance between pastoral groups and among households. They further generated specialised knowledge and working relationships, forming the backbone of natural resource management and sustainable livelihoods for the pastoralists. The evidence presented in this study shows that nowadays the rangeland utilisation is characterised by the expansion of permanent grazing land and uncontrolled encampments. Key grazing areas are being converted to crop cultivation. This leads to a reduced mobility of herds as the principal land use strategy, and linked to a reduced variability of stocking densities this causes over-grazing. Diversification into more small ruminants and dromedaries is interpreted as a means by which pastoralists try to adapt to the degrading environment. The severe disturbances of indigenous pasture management institutions and networking through development interventions and governmental decisions erode the preservation and future availability and application of IK. The consequence is a reduced co-operation between pastoralists. Internal processes of human population growth accelerate the downward trend of the Borana rangelands. Thus, the majority of the population face a progressive impoverishment linked with a higher susceptibility to droughts. Disputes over resources increase among the Borana pastoralists and with outsiders as they depend on reduced rangelands of lowered productivity. The available rangeland resources have become the most important factor limiting livestock performance. Against this background, the working hypothesis that Borana pastoralists can no longer make full use of their IK-based range management strategies due to inappropriate development interventions is accepted.

6.1 IMPORTANCE OF INDIGENOUS KNOWLEDGE

Pastoralists' ecological IK of the landscapes and the local livestock resources provides the information base for efficient livestock production, involving nutrition, breeding and veterinary practices (Figure 1). Fragmentation of the rangelands like in Dida Hara and Web not only causes over-grazing, but has more far reaching consequences. It constrains pastoralists' observation of and experimentation with natural processes. Thereby it impedes the utilisation of the existing IK and the generation of new IK to address new situations. In the Borana case, reducing the range for grazing limits the options to develop more diversified

range management strategies. It inhibits the use of herd splitting and herd stratification to fully exploit the accessible rangeland resources, and even may lead to an under-utilisation of peripheral rangeland resources. Important access and user rights to rangelands are getting abandoned, especially the temporary group rights for the seasonal grazing areas (*foora*). The incentives to preserve the rangelands diminish and the rehabilitation of degraded areas becomes increasingly unfeasible. Securing functional rangeland categories at a large-scale is therefore important to maintain rangeland quality and to develop sustainable livelihood strategies in the Borana rangelands.

Herd mobility depends upon a wealth of technological as well as organisational and management IK, which allows to match the needs of the herds with the available forage and water resources accounting for spatial and temporal resource variation. In the traditional system, herd mobility was linked with functional land use categories and resulted in seasonally varying stocking densities across the landscape. Thereby it preserved resting periods from grazing and allowed a rehabilitation of the pastures. Through mobility the herders generated actual information about the grazing conditions in order to flexibly react to the variable rainfalls and other external factors. Mobility fostered the co-operation and communication networks for the utilisation and maintenance of the rangeland resources and it contributed to secured survival during droughts. As Roe *et al*. (1998) have stressed, through herd mobility pastoralists are actively engaged in building technical and social competency for natural resource management including risk reduction. Mobility has also an impact on the social stability within pastoral groups and on the attitude towards outsiders[73]. Development interventions, which aim at maintaining social cohesion of pastoral societies, should therefore recall the social functions of mobility.

Mobility was a tool to maintain and to develop IK. Today, the advantages of herd mobility are still known among Borana elders. But mobility is applicable under restricted conditions only

[73] In the Borana case, mobility was interwoven with culture and can be considered as 'marker of identity' (Boku Tache, social systems development advisor, pers. comm., 2002). This manifests in the ritual migrations of the traditional leaders, who move during their ruling period across the Borana rangelands to perform ritual tasks along a defined route. A political connotation can also be assumed, as the sacral sites demarcate the Borana rangelands and traditionally involved the Borana society in delegating support for defending the area (Borbor Bule, Borana elder, pers. comm., 2002). During the research phase Borana pastoralists reported that the ceremonial grounds were intentionally destroyed by hostile pastoral groups and crop cultivation encroaching upon them. This was interpreted as an act of humiliation.

and especially the young generation has lost the expertise in range management. There is a scarcity in grazing resources, due to rangeland degradation as well as declining dry-season grazing reserves and open rainy-season pastures for the mobile herds. The continuous depletion of assets through droughts and alternative income generation possibilities have even led to disincentives to move. Under current conditions, mobility is regarded as a burden by the poorer livestock owners who can hardly afford to employ a herder and has become a commodity for the few wealthy herd owners. Thus, for the majority mobility has taken the character of an emergency driven tactic, instead of a key strategy for well organised rangeland and water utilisation. It is anticipated that the ongoing socio-economic differentiation and the loss of negotiating networks and information flows will lead to further reduction in mobility and thereby accelerate the loss of IK.

Although important preconditions for IK-based range management strategies have been jeopardised, Borana pastoralists envisage a flexible natural resource management based on their IK as the only way for endogenous development (A16 in ATable 1)[74]. The study suggests that the opportunity for mobility-based range management needs to be improved for those who are committed to make their living from livestock. Joint herding is an option for households with a minimum number of cattle, but requires strong social relationships. For the poor households mobility rather impedes their children from access to better education and therewith delays their transformation towards alternative income generation. Income diversification, banking and insurance modalities are needed as an alternative to the sole dependence on livestock; the possibility of creating new sources of income seems in this region however not very realistic. As herd mobility in the traditional form seems no longer feasible, a re-organisation of range management based on pastoralists' existing IK and taking account of the changed preconditions needs facilitation. A genuine approach, based on the locally persisting mobility patterns and viable organisational structures together with the pastoralists, is more promising than those of the past to improve the situation of the Borana. Local trends in herd diversification indicate how to support the land use system, towards spatial flexibility (dromedaries) or towards a combination with alternative sources of income (small ruminants). Focussing on the pastoralists' recent attempts for more controlled access to

[74] This is in agreement with de Bruijn and van Dijk (1999) saying that especially where modern infrastructures are under-developed, enhancing flexibility is decisive, to benefit from pooling resources and buffering risks from many sources of ecological, economic and political instabilities.

pasture and water might be helpful to debate about how to overcome disturbances and how to integrate future investments (f.e. education, income diversification, marketing and insurance facilities). By so doing development can make use of pastoralists' IK and it may enhance the local information exchange and technology capacity.

6.2 APPROPRIATE LOCAL INSTITUTIONS

The current knowledge in organisation and management (IK) of the Borana pastoralists is deficient. Significant investment in the revitalisation of indigenous institutions will be required, which is normally difficult to be achieved *ex-post* (compare ABox 5). Loosing the driving forces for mobility-based range management has contributed to the erosion of the highly effective land use classifications and institutional networks. This implies a considerable loss in human resources and social capital[75]. The reduced mobility makes the sustainable utilisation of available resources by local users more difficult. Pastoralists' adaptive reactions to climatic variability, disease outbreaks and market opportunities are hindered and local pasture rehabilitation measures can no longer be applied. Instead, an increasingly heterogeneous pastoral society and new stakeholders - such as the formal administration, development agencies, urban investors as well as military operators - show diverging interests in range use.

However, parts of the Borana communities still recall the indigenous structures for communication and control over natural resources. Furthermore, they have managed to keep the rangelands predominantly under common property, despite the scarcity of rangeland resources and individualisation trends (compare Kamara *et al*., 2003, 2004). The emerging privatisation of Borana rangelands can be attributed to conflicts of authority between the indigenous and the formal institutions (PA committees). But privatisation did not automatically expand, as the existing indigenous institutions still exerted some control. Thus, there is a potential to build on the local institutions for more sustainable utilisation of the Borana rangeland resources.

An appropriate grazing scenario for the Borana rangelands requires an institutional set-up

[75] At this point one should remember that development interventions creating pastoral co-operatives and organisations failed (e.g. the Producer Co-operatives (PC) and Service Co-operatives (SC) in Borana or the Kenyan group ranches) when they were not built on the local social structures. Creating new structures seems more difficult than 'repairing' the existing links.

which blends the traditional system with modern needs (Figure 2). It must be controlled by the local communities and integrate new forms of mobility and institutional arrangements to (re)activate IK and to keep it in action. The existing institutional structures favouring mobile range management have to be adapted to the constraints of scarce grazing resources, alarming poverty and additional stress through droughts and conflicts. New structures linking the traditional and modern institutions are required to strengthen the continuous negotiations over the use and maintenance of rangeland resources, especially in terms of transparent information transfer and enforcement of joint decisions. At the local-level, Borana pastoralists have involved the PA committees for strengthening community controlled grazing systems. Their initiative points at the strong need to create an efficient and legitimised formal administration in support of well established indigenous institutions. By so doing, the Borana pastoralists have opted to invest in a stronger community control of key grazing resources near the encampments and to enforce the accountability of households for their herds and land use. Creating more binding regulations for the most critical pastures for the lactating herds reflects essential principles of the key resource concept. The study also shows that the potential to apply mobility depends greatly on the specific situation of the local communities and individual households. Local institutions, therefore, should elaborate intensification pathways targeting at differentiated management profiles of the livestock keepers. This includes the local definition of co-operative herding groups and concerted measures for rangeland rehabilitation. Contributions of wealthier market-oriented pastoralists using common rangeland resources are required to support low income producers. The question of how to create suitable marketing and insurance facilities needs to be answered by the local users and responded by future development interventions. An appropriate integration of all strata of the Borana society into the relevant decision making bodies seems necessary to agree on clearly assigned tenure regimes and precise role descriptions in range management. Complementary support to stratified user profiles within and between communities and stimulation of the inter-relationships between them seems most appropriate to keep Borana households in pastoral production.

For pastoral oriented institution building in the Borana rangelands, external actors such as development agencies and government representations seem indispensable to enforce the decisions. They should act as arbitrators between pastoral groups and with outsiders. A basic model structure for more sustainable utilisation of rangeland resources with the assistance of IK of the Borana target group is suggested in Box 1. However, strategic political considerations might be involved to serve the interest of those with strong bargaining power

rather than finding socially efficient solutions (North, 1992). The lack of transparency and danger of political manipulation at different levels of governance can be avoided through pastoralists' participation and representation in decision making structures (Agrarwal, 2001). As Birner and Wittmer (2000) point out, the transaction costs of decision making due to an increase in number and the co-ordination expense might be higher when resource users participate, but it creates legitimacy and can reduce the future cost for implementing and enforcing management decisions. There is thus a need for new mediation platforms vertically to link the community based range management with arbitration of the government, and horizontally to link different pastoral groups in a cross-boundary structure (Bassi, 1997; Gebre Mariam and Kassa, 2001). Leonard (2004) adds that low income livestock producers could best express their collective interests through political associations or peer groups. The evidence provided by this study further supports the argument that enhancing pastoralists' innovative capacities requires a serious investment in appropriate formal education, capacity building and local infrastructure.

6.3 TRANSFERABILITY TO OTHER PASTORAL SYSTEMS

IK in range management strategies remains essential for pastoral systems due to the drought prone nature of the environment. It helps to preserve biological diversity and socio-economic stability. Thereby, mobility is the key strategy for sustaining flexible land use in dryland regions, which is also the case for rangeland systems differing from the Borana. For instance, in Namibia - a location with an unresolved land use policy - the organisational and management skills of the indigenous livestock keepers has been almost eradicated. The Herero apply mobility only in a rudimentary form, by selecting daily grazing directions or shifting the herds to private camps. Individual commercialised herd owners as well as local producer groups grab the communal rangeland, grazing on the commons and shifting to their private property once the commons are depleted (Fuller and Turner, 1995; Cox *et al*., 1998). The potential to restore community controlled grazing systems seems very low. However, building on their IK, Herero livestock keepers proposed a new allocation of natural resources. They opted for a local definition of commonly shared grazing units in preference to the individual resource tenure, and thereby confirmed common property scenarios making use of mobility (Homann and Rischkowsky, 2001; Krugmann, 2001). Experiences from more commercial range management systems show how mobility can be transformed by modern technology and adapted to new socio-economic situations. In the Middle East, the traditional authority systems became replaced, and surrogate migration developed. Cross border

networks for livestock sales are used during periods of forage shortage; telecommunication and trucks instead of dromedaries sustain the exploitation of remote pastures (Ngaido *et al.,* 1998; Rowe, 1999). These trends systems reflect the usefulness of mobility as a major tool to respond to the high fluctuations in forage supply. They require however a stronger economy, political stability and environmental conservation.

The challenge for future pastoral development planning is to design practical concepts for revitalising pastoralists' IK. The solution is not to romanticise this, but rather to support the proven practices and to redirect external interventions in order to support pastoralists' strategies in securing their livelihoods. Innovative approaches are needed to integrate indigenous and external knowledge in development planning and decision making. Herd mobility is perceived as a tool to activate pastoralists' technological, organisational and management IK, not as an end in itself. It is suggested that the stepwise approach for exploring IK-based rangeland management developed in the present research study is transferable to other pastoral systems (Figure 12):

Step 1: Identifying the constituents of mobile rangeland management

Consulting a historical perspective and contrasting locations with a difference in traditional functionality and development interventions reveals the rationale of the local strategies and the negative effects of interventions in the name of pastoral 'development'. Selected technical tools help to identify the constituents of mobility-based rangeland management and to better understand the local complex interactions between pastoral management strategies.

Step 2: Determining socio-economic profiles of mobile households

Locally defined mobility indicators are tested against a set of locally defined explanatory socio-economic variables, accounting for different stages in drought cycles. This reveals the socio-economic features favouring mobility, which are site specific and influenced by temporal frame conditions. Targeting mobile user profiles can help to enhance more controlled range management in a special context.

Step 3: Exploring the development and potential of indigenous institutions

The local changes in institutional networks regulating natural resource management are analysed by participatory community meetings. The comparison of the situation before the interventions and today shows how the organised common access to rangeland and water has been disturbed. It also reveals the still viable organisational structures and current initiatives of the pastoralists in adapting their strategies to changing conditions.

Step 4: Initiating and encouraging multi-stakeholder platforms

Inviting representatives from the local communities, research, development and the government provides platforms for joint reflection to support ongoing efforts in participatory development planning. The debates support consensus on targets among the multiple actors and agents for a given time frame. They sustain a redefinition of institutional responsibilities of indigenous and formal structures for appropriate land use. Thereby they can directly lead to an embedding of modernised institutional networks into regional administrative structures and appropriate policy frameworks.

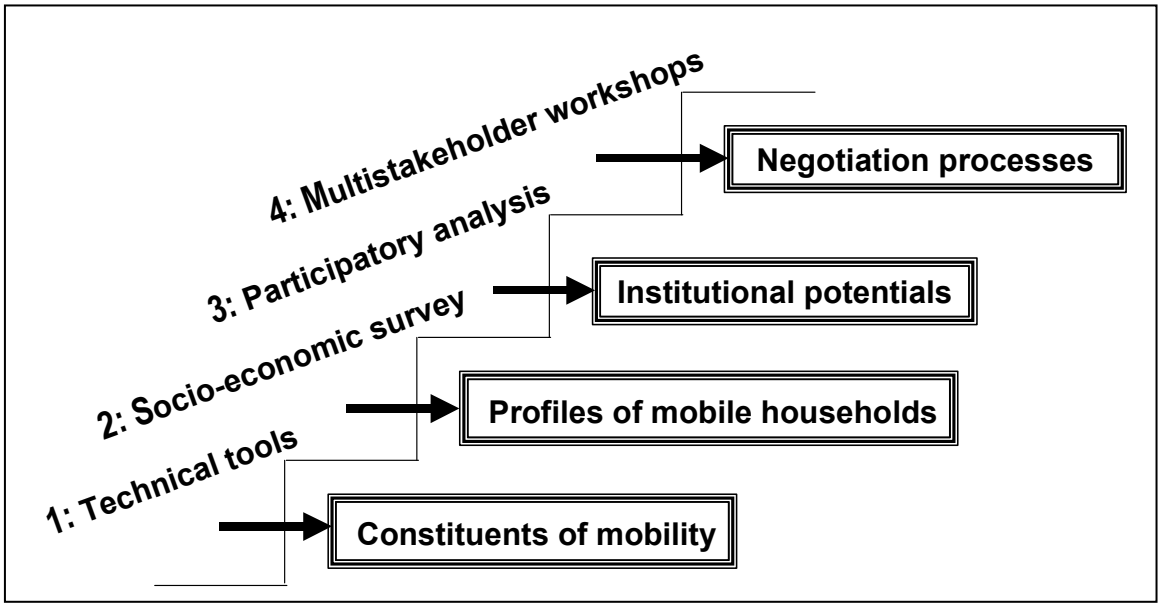


Figure 12. A stepwise approach for exploring pastoralists' IK in rangeland management strategies.

Source: own design.

In pastoral systems the suggested stepwise approach focussing on mobility provides specific knowledge on pastoralists' rangeland management strategies and the current constraints to applying them. Thereby it arrives at concrete options for improved rangeland management in a local context, integrating pastoralists' existing IK and their co-operative capacities. It supports the institutionalisation of negotiation processes, based on an informed debate and mediated by local development agents. The agents should support pastoral communities in redefining their objectives, further developing their innovations and strengthening the constructive use of networks. Restructuring mobile rangeland management will not turn back the clock or overcome the fact that many pastoral households depend on additional income and can no longer survive on livestock. However, exploring pathways to support mobility and pastoral control of resource use can make development approaches more tangible and target-

oriented.

A challenge for future research is to address mobile pastoralists for *in situ* experimentation and decision making upon range management. The technological and institutional improvements need to be re-invested in the process of endogenous pastoral development (Figure 2). The adaptation of local mobility patterns and institutional frameworks for regulating natural resource use need to be documented for normal years as well as during crisis and recovery. This should support the validation and re-implementation of newly generated knowledge. The study concludes that developing range management in consultation with pastoralists, through IK and involving scientific knowledge and development actors' experience, is more likely to meet the needs of the primary stakeholders and fits better to the drought prone environment.

7 SUMMARY

The Borana pastoralists' indigenous knowledge (IK) about range ecology, livestock resources and social organisation has developed highly efficient range management strategies to deal with the high-risk environments of arid lands. Traditionally, the supply of permanent water was limited to clusters of deep wells in the central area. Access to water played a major role in the management of the surrounding pastures. Herd mobility, linked with flexible stocking densities and herd diversification, was practised as key strategies to exploit the heterogeneous rangeland resources on a large-scale. Common property regimes, with their customary legitimacy, were designed for extended user groups to co-ordinate and enforce decisions over the access to shared grazing resources. The local decision making structures were flexible enough to allow multiple users to negotiate over the use of key resources during times of scarcity. However, since the 1970s various development interventions ignoring the importance of the Borana pastoralists' IK have undermined pastoral production. Government decisions and changing land use policies in connection with political upheavals further disturbed the indigenous institutions. This has resulted in socio-economic instability and ecological degradation. The case study was conducted to test the general hypothesis that, today Borana pastoralists can no longer make full use of their IK-based range management strategies due to inappropriate development support.

The research was set-up in co-operation with the Borana Lowland Pastoral Development Programme (BLPDP/GTZ), and was carried out from October 2000 to July 2002. The study targeted two pastoral scenarios with a different functionality in the traditional system and a difference in external interference. Dida Hara district represented a former rainy-season grazing area where permanent watering ponds were constructed in the 1970s with the aim to improve the overall range use efficiency. Web district represented a traditional dry-season grazing area associated with one of the deep well clusters and permanent supply of good quality water. The research methods were structured as an iterative problem solving process, starting with the pastoralists' definition of main constraints, evaluating applied strategies by participatory appraisals (PRA) and quantitative assessments, searching for improvements and discussing them at several multi-stakeholder workshops. A complementary study by Gemedo Dalle assessed pastoralists' ecological IK and measured the rangeland conditions using scientific indicators on the same sites.

A first sub-hypothesis tested that external interference in Borana rangelands ignoring pastoralists' IK destroys the basic preconditions of the applicability of IK-based range management strategies, measured by herd mobility and variability in stocking densities. The situation of Dida Hara and Web today was compared with the situation before the start of external interventions 30 years ago. A socio-economic baseline survey was conducted for 182 and 58 households at three selected encampment clusters in Dida Hara and Web, respectively. Subsequently a socio-economic in-depth survey was conducted based on a sub-sample of 60 households. The households' herd movements during and after the last drought and their herd dynamics before and after the drought were recorded. Participatory Rural Appraisal (PRA) techniques, group discussions and key person interviews, Geographic Positioning Systems (GPS) and official maps were used to assess the ecological rangeland classification and utilisation patterns, indigenous institutions and breed preferences of the pastoralists. Body weights of a total of 543 cattle of the local breed types were estimated from linear body measurements during the peak dry and rainy-seasons. Progeny histories were recorded for 453 cattle, 217 goats and 183 dromedaries to estimate the current livestock performances.

Strong evidence is provided that the natural-resource-based economy of Borana pastoralists has been disturbed by external interference. The implementation of watering ponds in the formerly seasonally used pastures opened the rainy-season area for year-round grazing and attracted uncontrolled encampments. At the same time, imposition of a top-down formal administration (PA committees) undermined the indigenous institutions of pasture management. Another destabilising factor was the political decision of the Federal Government of Ethiopia to hand over about one third of the Borana rangelands and two important well clusters to the neighbouring Somali Administrative Region. This effectively denied the Borana access to the most fertile pastures, destroyed reciprocal arrangements between Borana and Somali pastoral communities and fuelled ethnic conflict. The extension services favoured cultivation within valuable grazing areas and blocked herd movements. The official ban on rangeland burning and the establishment of private commercial ranches exacerbated the disruption of the Borana traditional resource-use system. An alarming growth of the human population and recurrent droughts put further pressure on the natural resources.

The development interventions have reduced IK-based range management strategies in Dida Hara and Web. One year after the last drought in Borana rangelands, there were

scarcely any herd movements in Dida Hara, the location where water ponds had been constructed, but mobility was still pronounced in Web. Mobility during the drought was similar at both locations, as herd movements were driven by the crisis. The reduced mobility was reflected by a lower variability in stocking densities. Little variability was recorded for Dida Hara, but it was still evident for Web due to high inflow of external herds during the long dry-seasons. The current land use in the Borana rangelands was more short term oriented and common patterns were hardly observed. This had a negative effect on directly related IK, shown by the loss of rangeland evaluation by experienced scouts, the destruction of information transfer and decision making structures, and the abandoning of supplementary strategies for improved livestock production.

The impact of the interventions was more profound and jeopardised important preconditions for the IK-based range management strategies. Fragmentation of rangeland classification and utilisation patterns led to different scenarios in Dida Hara and Web. After the construction of water ponds encampments in Dida Hara have expanded rapidly, and long-distance rainy-season movements were no longer needed. A few wealthy Borana established very large herds, whereas most households barely sustained their livelihoods from livestock. Households co-operated much less in herding, their animals were more likely to die during droughts, and the formerly abundant pastures degraded rapidly. The herders from Web had less rainy-season grazing areas for their mobile herds and became confined to areas closer to the deep wells. Within this group of pastoralists, the gap in wealth remained less and most households continued to co-operate in managing very small herds. Disturbance of the Borana institutions regulating natural resource management has eroded the organisational expertise to co-ordinate the access to water and rangelands as well as to preserve social security and good governance. Weaknesses in power structures and related conflicts aggravated the impoverishment linked with higher susceptibility to droughts for the majority of the population, while a minority of wealthy herd owners was able to assure their access to pastures through corruption. The results from the range ecology study showed that the Borana rangelands are deteriorating. The pastoralists in Dida Hara and Web have adjusted their breeding strategies by selecting for a cattle breed with lower demands for forage, and by increasingly keeping dromedaries. They further gave up the satellite herds of castrated males, formerly a

precious reserve to overcome droughts. The progeny histories confirmed a reduced performance of livestock. These experiences show very clearly that ignoring Borana pastoralists' IK contributes to progressive erosion of important social structures, degradation of rangelands and poverty.

A second sub-hypothesis tested that socio-economic household characteristics determine the application of IK-based range management strategies, measured by herd mobility and various indicators for herd diversification. The statistical analysis was based on the in-depth survey with 60 selected households in Dida Hara and Web.

Different socio-economic household characteristics of the Borana pastoralists exerted an influence on the IK-variables, depending on the stages of drought and with reference to the sample location. This referred mainly to mobility, to a lesser degree also to herd diversification. Mobility during the last drought was higher for those households who sold their animals at export markets. In the year after the drought, households in Web were more mobile than in Dida Hara. Mobility increased when the households were part of larger herding groups and was higher for households with enough animals to live on livestock alone. Households with dromedaries were more mobile than others. Herd diversification before the last drought differed by location, as more cattle were found in Dida Hara and more dromedaries in Web. Keeping dromedaries was less frequent for households with more alternative income generation. After the drought, the dominance of cattle was reduced in Dida Hara and small ruminants became more important. This was especially for households with more crop cultivation and indicated a trend towards alternative income generation. Whereas keeping more dromedaries was found for households with larger herds and access to larger co-operation groups, indicating more flexible land use. The adoption rate of dromedaries before the drought was higher for households with larger herds, and after the drought households with sufficient manpower and equipment maintained dromedaries. The location did not influence the decision to adopt dromedaries. Finally, testing the relationship among the IK variables confirmed that keeping dromedaries influenced a households' decision for mobility and is therefore recommended for revitalising IK-based range management with Borana pastoralists. However, under current conditions, mobility did not prevent the high mortality during the drought. Herd diversification only has led to reduced mortality of cattle. Instead, mobility had a negative impact on the net herd growth of cattle and dromedaries after the drought. Among the socio-economic variables notably the sample

locations Dida Hara and Web caused differences in the herd dynamics and thereby they give another evidence for the different potentials to make use of IK.

These results conform to the hypothesis that inadequate development support restricts pastoralists in Borana rangelands from making full use of their IK-based range management strategies. The consensus reached at final multi-stakeholder workshops affirmed that pastoralists' IK was under-utilised and must be revitalised. Herd mobility depends upon a wealth of technological as well as organisational and management IK, which fosters the networks of co-operation and communication for the utilisation and maintenance of the rangeland resources including risk reduction. As herd mobility in the traditional form seems no longer feasible, a re-organisation of range management based on pastoralists' existing IK but taking account of the changed preconditions needs facilitation. A genuine approach is based on viable organisational structures for continuous experimentation and negotiation with the pastoralists and preserves legitimacy. Appropriate local and well established institutions are challenged to define sustainable land use profiles and institutional responsibilities, and to promote land use diversification within and between rangeland systems. External actors such as development agencies and government representations seem indispensable to enforce the decisions, and should act as arbitrators. There is a need for new mediation platforms, vertically to link the community based range management with arbitration by the government, and horizontally to link different pastoral groups in a cross-boundary structure. In times when conflicts over resources as well as political and economic interests gain complexity, pastoralists' political organisation and favourable pastoral policy development are very critical elements. Significant investment in local income diversification, marketing and saving facilities, as well as formal education and capacity building are necessary to keep IK in action or to reactivate it.

It is suggested, finally, that if the above outlined principals are adhered to, they can with appropriate local adaptation be transferred to other pastoral systems in Africa or Central Asia to sustainably utilising rangeland resources with the assistance of IK of the target groups.

8 ZUSAMMENFASSUNG

Das indigene Wissen (IW) der Borana-Pastoralisten über Weideökologie, Tierressourcen und soziale Organisation hat besonders effiziente Strategien zur Bewirtschaftung der natürlichen Ressourcen in Trockengebieten mit hohem Produktionsrisiko entwickelt. Traditionell war das permanente Angebot von Wasser auf zentral gelegene Tiefbrunnen beschränkt. Über den Zugang zu Wasser wurde die Nutzung der umliegenden Weiden reguliert. Herdenmobilität, in Verbindung mit flexiblen Besatzsdichten und Herdendiversifizierung, war die Schlüsselstrategie zur Nutzung heterogener Weideressourcen. Gemeinschaftsweiderechte waren legitimiert und auf große Nutzergruppen ausgerichtet, um Entscheidungen über den Zugang zu geteilten Ressourcen koordinieren und durchsetzen zu können. Die lokalen Entscheidungsstrukturen waren flexibel genug, um in Knappheitsphasen verschiedenen Nutzern Verhandlungen über die Nutzung von Schlüsselressourcen zu ermöglichen. Seit den siebziger Jahren wurden Entwicklungsmaßnahmen durchgeführt ohne die Bedeutung des IW der Pastoralisten zu berücksichtigen. Regierungsentscheidungen und geänderte Landnutzungsrechte in Verbindung mit politischen Auseinandersetzungen haben außerdem die indigenen Institutionen geschwächt. Dies hatte sozio-ökonomische Instabilität und die Degradation der Weiden zur Folge. Die Fallstudie testet deshalb die allgemeine Hypothese, daß heute die Borana-Pastoralisten wegen unangepaßter Entwicklungsmaßnahmen ihre auf IW basierenden Strategien zur Weidebewirtschaftung nicht ausschöpfen können.

Die Feldforschung wurde in Zusammenarbeit mit dem Borana Lowland Pastoral Development Programme (BLPDP/GTZ) im Zeitraum Oktober 2000 bis Juli 2002 durchgeführt. Zwei Standorte mit unterschiedlicher Funktion im traditionellen Weidesystem und unterschiedlichem Eingriff durch Entwicklungsmaßnahmen wurden verglichen. Dida Hara ist ein ehemaliges Regenzeitweidegebiet, wo in den siebziger Jahren Wasserstellen gebaut wurden, um die Effizienz der Weidenutzung zu verbessern. Web ist ein traditionelles Trockenzeitweidegebiet um ein Zentrum von Tiefbrunnen gelegen, mit dauerhaftem Angebot von hochwertigem Wasser. Die Forschungsmethoden waren als iterativer Problemlösungsprozess strukturiert, beginnend mit der Definierung der Hauptengpässe durch die Pastoralisten, dann die Evaluierung der Nutzungsstrategien durch partizipative Ansätze (PRA) und quantitative Erhebungen, und schließlich die Suche nach Lösungen und deren Diskussion auf Multistakeholder-Workshops. Eine ergänzende Studie von Gemedo Dalle hat das ökologische IW der Pastoralisten und den ökologischen Zustand der Weiden auf denselben Standorten erhoben.

Eine erste Unterhypothese hat getestet, ob Entwicklungsmaßnahmen, die das IW der Borana nicht beachtet haben, die Grundvoraussetzungen für die Anwendbarkeit indigener Strategien der Weidenutzung (gemessen in Herdenmobilität und Variabilität der Besatzsdichten) zerstört haben. Die heutige Situation in Dida Hara und Web wurde mit dem Zustand vor Beginn der Interventionen vor 30 Jahren verglichen. Eine sozio-ökonomische Grunderhebung wurde über jeweils drei Siedlungscluster mit 182 Haushalten in Dida Hara und 58 Haushalten in Web durchgeführt. Danach wurde eine sozio-ökonomische Tiefenstudie über eine Unterstichprobe von 60 Haushalten durchgeführt, die auch die Mobilität während und nach der letzten Dürre und die Herdendynamik vor und nach der Dürre umfaßte. Partizipative Techniken (PRA), Gruppendiskussionen und Schlüsselpersoneninterviews, Geographische Positionssysteme (GPS) und offizielle Karten wurden zur Aufzeichnung der Weideklassifizierung, Landnutzungsmuster, institutionellen Netzwerke und Zuchtpräferenzen genutzt. Lebendgewichte von 543 ausgewachsenen Rindern während der Regen- und Trockenzeit wurden durch lineare Körpermessungen geschätzt. Die gegenwärtige Nutztierleistung wurde über die Nachzuchtgeschichte von 453 Kühen, 217 Ziegen und 183 Kamelstuten geschätzt.

Der Erweis wurde erbracht, daß die Bewirtschaftung natürlicher Ressourcen der Borana Pastoralisten durch äußere Eingriffe gestört worden ist. Der Bau der Wasserstellen in ehemaligen Regenzeitweiden hat eine ganzjährige Beweidung und die Zersiedlung der ehemals temporär genutzten Flächen bewirkt. Gleichzeitig hat die Einrichtung der formalen Verwaltung (PA Komitee) indigene Institutionen in der Weidewirtschaft unterwandert. Weitere Destabilisierung kam durch die politische Entscheidung der athiopischen Regierung, ein Drittel der Borana-Weideflächen und zwei Brunnenkomplexe an die somalische Verwaltungsregion abzutreten. Dadurch wurde den Borana-Pastoralisten der Zugang zu den besten Weiden entzogen, reziproke Beziehungen zwischen pastoralen Gruppen zerstört und ethnische Konflikte geschürt. Der Beratungsdienst hat Ackerbau an wertvollsten Weidestandorten unterstützt, und die Tierhaltung benachteiligt. Weiterhin haben das offizielle Verbot des Weidebrennens und die Einrichtung privater kommerzieller Farmen das traditionelle Nutzungssystem der Borana behindert. Bevölkerungswachstum und wiederkehrende Dürren üben zusätzlichen Druck auf die natürlichen Ressourcen aus.

Die Eingriffe haben auf IW basierende Strategien zur Weidebewirtschaftung in Dida Hara und Web eingeschränkt. Ein Jahr nach der letzten Dürre im Boranagebiet gab es kaum Herdenwanderungen in Dida Hara, dem Standort mit neuen Wasserstellen, wohl aber in Web. Während der letzten Dürre war Mobilität in Dida Hara und Web ähnlich ausgeprägt, da durch

die Krise bedingt. Eine reduzierte Mobilität wurde durch eingeschränkte Variabilität der Besatzsdichten bestätigt. Wenig Variabilität wurde in Dida Hara festgestellt, war aber ausgeprägt in Web wegen der hohen Zuwanderung externer Herden in Trockenzeiten. Landnutzung im Borana-Gebiet war kurzfristig und gemeinsame Muster waren kaum erkennbar. Dies hatte negative Auswirkungen auf unmittelbar damit verbundenes IW, wie sich im Verlust der Weideevaluierung durch erfahrene Hirten, der Zerstörung der Informations- und Entscheidungsstrukturen und der Aufgabe ergänzender Maßnahmen zur Steigerung der tierischen Produktion zeigte.

Die weitreichenderen Auswirkungen der Eingriffe haben zur Zerstörung der Voraussetzungen für indigene Strategien zur Weidebewirtschaftung geführt. Die Fragmentierung der Weideklassifizierung und Nutzungsmuster hat unterschiedliche Szenarios in Dida Hara und Web herbeigeführt. Nach dem Bau der Wasserstellen in Dida Hara breiteten sich dort schnell Siedlungen aus und lange Wanderungen in Regenzeitgebiete waren nicht mehr nötig. Wenige reiche Haushalte vergrößerten ihre Herden ohne viel Aufwand, die meisten aber konnten ihren Lebensunterhalt kaum gewährleisten. Die Hauhalte haben weniger in der Herdenführung kooperiert, mehr Tiere starben in der letzten Dürre, und die ehemals üppigen Weiden degradierten schnell. Haushalte in Web hatten keine Regenzeitweiden mehr für die mobilen Herden zur Verfügung und waren auf die Gebiete nahe an den Brunnenzentren angewiesen. Wohlhabende Herdenbesitzer waren seltener und die meisten Haushalte kooperierten in der Führung sehr kleiner Herden. Die Störung der indigenen Institutionen hat das organisatorische Fachwissen zur Weidebewirtschaftung, Erhaltung sozialer Sicherheit und verantwortungsbewußter Kontrolle geschwächt. Mängel in den Machtstrukturen und damit verbundene Konflikte haben die Verarmung der Bevölkerung verschlimmert und deren ökonomische Anfälligkeit bei Dürren erhöht, während eine wohlhabende Minderheit sich ihren Zugang zu Weiden durch Korruption sichert. Die Studie zur Weideökologie hat bestätigt, daß die Weiden in dem Borana-Gebiet degradieren. Die Pastoralisten in Dida Hara und Web haben ihre Zuchtstrategien an die verschlechterten Umweltbedingungen angepaßt, durch Auswahl kleinrahmiger Rinder mit geringeren Futteransprüchen und durch den Beginn der Kamelhaltung. Außerdem wurden die Herden kastrierter Rinder aufgegeben, ehemals wertvoll zur Überbrückung von Dürren. Die Nachzuchtgeschichten haben bestätigt, daß sich die tierische Leistung in dem Boranagebiet verschlechtert hat. Diese Ergebnisse machen deutlich, daß die Nichtbeachtung des IW der Borana-Pastoralisten zur Erosion wichtiger Sozialstrukturen, Weidedegradation, Minderung der Veredelungsproduktion und Armut beiträgt.

Eine zweite Sub-hypothese hat getestet, ob die Anwendbarkeit indigener Strategien zur Weidebewirtschaftung durch sozio-ökonomische Haushaltsmerkmale bestimmt wird (gemessen in Herdenmobilität und anhand verschiedener Indikatoren für die Herdendiversifizierung). Die statistische Auswertung basierte auf Daten der 60 ausgewählten Haushalte in Dida Hara und Web.

Verschiedene sozio-ökonomische Haushaltseigenschaften der Borana-Pastoralisten hatten Einfluß auf die indigenen Strategien, je nach Dürrestadium und oft mit Bezug zu den Standorten. Dies galt vornehmlich für Herdenmobilität und in geringerem Ausmaß auch für die Herdendiversifizierung. Mobilität während der letzten Dürre war stärker ausgeprägt für Haushalte mit Zugang zu Exportmärkten. Im Jahr nach der Dürre waren Haushalte in Web mobiler als in Dida Hara; Mobilität stieg wenn Haushalte in größeren Gruppen bei der Herdenführung kooperierten und wenn sie genug Tiere hatten um davon leben zu können. Haushalte mit Kamelen waren mobiler als andere. Herdendiversifizierung vor der Dürre unterschied sich je nach Standort, mit mehr Rindern in Dida Hara und mehr Kamelen in Web. Kamelhaltung war bei Haushalten mit alternativen Einkommensquellen seltener. Nach der Dürre waren die Rinder in Dida Hara dezimiert und kleine Wiederkäuer wurden wichtiger. Dies galt besonders für Haushalte mit mehr Ackerbau und wird als Trend zu alternativem Einkommenserwerb interpretiert. Mehr Kamele gab es in Haushalten mit großen Herden und Kooperation in größeren Gruppen, und deutet auf flexiblere Landnutzung hin. Das Halten von Kamelen war vor der Dürre stärker bei Haushalten mit einer größeren Herde verbreitet und nach der Dürre bei Haushalten mit genug Arbeitskraft und Ausstattung. Der Standort hatte hierauf keinen Einfluß. Bestätigt wurde, daß Kamelhaltung Mobilität fördert, und wird daher für die Stärkung indigener Weidewirtschaft empfohlen. Jedoch hat unter den gegenwärtigen Bedingungen Mobilität nicht zur Vermeidung von Tierverlusten in der Dürre beigetragen. Nur Herdendiversifizierung hat die Mortalität von Rindern reduziert. Stattdessen hatte Mobilität negative Auswirkungen auf das Netto-Herdenwachstum von Rindern und Kamelen nach der Dürre. Von den sozio-ökonomischen Determinanten hatte besonders der Standort einen Einfluß auf die Herdendynamik und zeigt damit die unterschiedlichen Potentiale für IW in Dida Hara und Web auf.

Die Ergebnisse bestätigen die Hypothese, daß unangepaßte Entwicklungsmaßnahmen Pastoralisten in der Nutzung der auf IW basierenden Strategien zur Weidebewirtschaftung behindern. Auf den Multistakeholder-Workshops wurde übereinstimmend betont, daß IW nicht ausreichend genutzt worden ist und revitalisiert werden muß. Herdenmobilität bedingt

reichhaltiges technologisches und organisatorisches IW, welches Kooperation und Kommunikation zur Nutzung und Erhaltung natürlicher Ressourcen stärkt und zu einer Risikominderung führt. Da Herdenmobilität in der traditionellen Form nicht mehr anwendbar scheint, muß eine Reorganisation der Weidewirschaft gefördert werden, basierend auf dem existierenden IW der Pastoralisten und den geänderten Rahmenbedingungen Rechnung tragend. Ein genuiner Ansatz basiert auf tragfähigen Organisationsstrukturen für dauerhaftes Experimentieren und Verhandeln mit den Pastoralisten und erhält Legitimität. Angemessene lokale und in der Zielgruppe der Pastoralisten fest verwurzelte Institutionen sind gefordert, nachhaltige Landnutzungsprofile und institutionelle Zuständigkeiten zu definieren, und die Diversifizierung in der Landnutzung innerhalb und zwischen verschiedenen Weidesystemen zu unterstützen. Externe Akteure wie Entwicklungszusammenarbeit und Regierungsvertreter sind unabdingbar um Entscheidungen durchzusetzen, und sollten zur Schlichtung bei Konflikten beitragen. Es gibt einen Bedarf neuer Formen für Vermittlung, vertikal um die gemeinschaftliche Bewirtschaftung natürlicher Ressourcen mit der Regierung zu verbinden, und horizontal um verschiedene pastorale Gruppen über stattliche Grenzen hinweg zu vernetzen. In Zeiten, wo Konflikte sowie ökonomische und politische Interessen an Komplexität gewinnen, werden die politische Organisation von Pastoralisten und förderliche gesetzliche Rahmenbedingungen besonders kritisch. Deutliche Investitionen in lokale Einkommensdiversifizierung, Vermarktung und Sparmöglichkeiten, als auch in Ausbildung und Kapazitätenaufbau sind notwendig um IW in Aktion zu halten bzw. wieder zu aktivieren.

Es wird der Vorschlag gemacht, daß die oben aufgezeigten Prinzipien bei angemessener Anpassung an den lokalen Kontext auf andere pastorale Systeme in Afrika oder Zentralasien übertragen werden können und dort zur nachhaltigen Weidebewirtschaftung mit Hilfe des IW der Zielgruppen beitragen können.

9 APPENDIX

LIST OF ATABLES

LIST OF AFIGURES

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ATABLES

ATable 1. Data collection of the case study (tools, time, target groups, objectives, guidelines for questioning).

Thematic interviews conducted and qualitative assessments

Natural resource management

A1) Introductory meetings: discussions and participatory land use mapping (12/2000)

Community members at selected encampment clusters (*ardaa*) (3 meetings in Dida Hara and 3 in Web, 10-42 participants)

Objectives:
- Introduce the researchers and the purpose of the research study to the sample communities
- Identify local problems in range and water management, today in comparison to 4 *abba gadda* (32 years) ago
- Identify local land use categories during dry and rainy-seasons
- Feed back from the community on content and process of the research study

Guideline:
- Introduction and presentation of the research project!
- What are main problems facing the use of rangeland and water resources? Could you rank them in order of their importance!
- Could you map the area of your *ardaa* (natural characteristics, *ollas* (encampments) and infrastructures)?
- Could you indicate the different land use categories during dry and rainy-seasons (encampment area, livestock specific grazing area, watering zones, forage banks, cultivation fields)? Where are particularly degraded areas?
- Did you use the same land use categories 4 *abba gadda* (32 years) ago? Why did you change the land use system?
- What problems should be prioritised by the research study?

A2) Key person interviews: land use history (12/2000-01/2001)

Knowledgeable elders at selected PAs (3 interviews in Dida Hara and 3 in Web)

Objectives:
- Identify indigenous rangeland classification and land use patterns for the Borana rangelands, today in comparison to the situation before the external interventions arrived

Cont.: next page

Guideline:
- What are the main soils in your PA and where do they prevail? What areas are of particular high or low grazing potential? What sites are more suitable for cattle, dromedary or small stock?
- What areas in Borana rangelands are typically kept as dry or rainy-season grazing reserves - today and in comparison to 4 *abba gadda* (32 years) ago? What areas have been converted to permanent grazing during the last 4 *abba gadda* (32 years)? Is there still access to *forra* (seasonal grazing) areas?
- Who are the traditional experts in rangeland and water management? How do they get their knowledge and how do they transfer it? How do you know where good pasture is, where diseases break out, about livestock markets and crop cultivation techniques?
- Who is responsible for the regulation of water and pasture within your grazing area? What areas are (temporarily) restricted for grazing? For what purpose? Who protects them? Do you impose restrictions on livestock species or numbers for grazing areas or grazing times? Did the restrictions change during the last 4 *abba gadda* (32 years)? Why? Did trespassing of the restrictions occur? How were they sanctioned?
- What is the function of indigenous institutions for rangeland and water management today compared to 4 *abba gadda* (32 years) ago?
- What formal institutions have an impact on rangeland and water management? How?
- What types of meetings did you held in years with average rainfall and during droughts?
- Which types of courts were necessary because of conflicts or trespassing rules? Did they resolve the problems?
- How did your PA cope with the last drought? Did you give permission to other herders to graze in your area? Which specific measures in range management did the community apply to cope with the last drought? Where did they fail? What the community could do to better cope with drought?

A3) Discussions in small groups: seasonal grazing areas and herd movements (05-07/2001)

Elders and herders at selected encampment clusters (*ardaa*) (3 sessions in Dida Hara and 3 in Web, 4-8 participants)

Objectives:
- Identify seasonal grazing areas for the selected encampment clusters
- Characterise household's local herd movement patterns
- Determine local restrictions in mobile rangeland management

Guidelines:
- What are the most important fodder plants for cattle, dromedary, goats and sheep - during rainy and dry-seasons? Where are they to be found? Are they sufficiently accessible and available? If not, why not?
- What sources of water do you use for cattle, dromedaries, goats and sheep - during rainy and dry-seasons? How frequently do you water the different livestock species over the year? What about the quantity and quality of the respective supply?
- How many herds of cattle, dromedaries and small ruminants do you keep at your *ardaa*? Of what productive status are they (calves, milking herd, dry herd)? Where do they graze over the year? How far are the grazing areas from your home? When during the day do you send your herds for grazing?
- What are the criteria to rank a household as high, medium or low in mobility? Did they change for the situation during and after the drought?
- Did you observe any change in rangeland quality compared to former times? How did you adapt in management?

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A4) Discussions in small groups: matrix of seasonal stocking densities (05/2001; 05/2002)

Elders and herders at selected encampments clusters (*ardaa*) (3 sessions in Dida Hara and 3in Web, 4-8 participants)

Objectives:
- Approximate seasonal stocking densities and variability in stocking densities

Guidelines:
- How many animals make up a large, middle and small herding group for cattle, dromedaries, goats and sheep?
- How many large, middle, small herding groups of cattle, dromedaries, goats and sheep were grazing in your *ardaa* during main rainy-season, small dry-season, small rainy-season, severe dry-season during the year before the drought (1997/98) and after the drought (2001/02)?
- Could you collect stones of large, middle and small size and put them on the calendar sheet, representing the number of herding groups grazing in your area during the indicated seasons and years?

A5) Key person interviews: interpretation of satellite pictures (12/2001)

Knowledgeable elders at selected PAs (2 interviews in Dida Hara and 2 in Web)

Objectives:
- Map indigenous landscape categories for the Borana rangelands
- Cross-check pastoralists' information on land use classification and movement patterns

Guidelines:
- Do you recognise the natural features (deep wells, salt craters, mountain ranges, forests) on the satellite picture of Borana rangelands?
- Could you determine the indigenous landscape categories being used 4 *abba gadda* (32 years) ago?
- Where did the herds traditionally used to move during dry-seasons and during rainy-seasons?

A6) Household interviews: mobility in-depth survey (03-04/2002)

Heads of households at selected encampment clusters (*ardaa*) (31 interviews in Dida Hara and 29 in Web)

Objectives:
Determine ranks of mobility at household-level, during and after the last drought

Guideline:
- By how many groups of cattle, dromedaries and small ruminants did you move for grazing - during the last drought (March 1999-February 2001) and the year after the drought (March 2001-February 2002)?
- Where did the different herding groups graze? How far were those locations from your home? How long did they stay? When did they shift the herds to the next location? Why?

A7) Key person interviews: water management (01-03/2001)

Managers of deep wells and newly constructed ponds (3 interviews in Web and 3 in Dida Hara)

Objectives:
- Identify responsibilities, strategies, rules and regulations in water management

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Guidelines:
- What are the tasks and responsibilities of the water manage (*abba herrega*)r? What other operators are involved in water management? What are their tasks and responsibilities?
- Who can have access to your well/pond? Does this change seasonally and during droughts?
- What are the regulations for watering cattle, dromedaries and small ruminants? Does this change seasonally and during droughts?
- How many groups of cattle, dromedaries, small stock drink at your well/pond during the beginning dry-season, the late dry-season and during droughts?
- According to which criteria do you determine the frequency of watering for the different livestock species over the year?

A8) Discussions in small groups: additional management issues (05-07/2002)

Elders, herders and women at selected encampment clusters (*ardaa*) (3 sessions in Dida Hara and 3 sessions in Web)

Objectives:
- Describe local breeding preferences
- Identify thresholds for herd size and crop cultivation
- Describe indigenous rangeland evaluation and improvement

Guideline:
- Which cattle breeding types do you prefer? For which characteristics (milk, meat, drought resistance, low fodder intake, competitive under high grazing pressure)? What colour do you prefer for skin and horn? Which are your criteria for selecting breeding bulls and females? How do you measure their performance?
- How many cattle, dromedaries, goats and sheep are necessary for a household to survive / not to be considered as poor? How much cultivated area is necessary for a household to survive?
- How do you make your decisions for particular range management strategies, such as planning of herd movements, collection and evaluation of information, maintenance and improvement of pasture and water, preparations for drought? On which information are these decisions based? Who is mainly responsible for these tasks over the year?

Livestock

A9) Key person interviews: functional livestock categories (05/2002)

Herders in Dida Hara and Web (6 interviews)

Objectives:
- Identify functional livestock categories for cattle, small ruminants and dromedaries

Guidelines:
- What categories for livestock do you differentiate, according to sex and age?
- At what age do you wean calves of cattle, dromedaries, sheep and goats? At what age do you castrate males? For what purpose?
- Do you split the herds for grazing? According to what criteria?
- What are the advantages/disadvantages of cattle, small ruminants and dromedaries?
- What are further measurements for improved livestock production? How applied?

A10) Herd owner interviews: livestock progeny history (03/2001 – 05/2002)

Herd owners in Dida Hara and Web (characterising female breeding animals of 453 cattle, 183 dromedaries and 217 goats)

Objectives:
- Characterise the productivity of cattle, dromedaries and goats

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Guideline:
Questions concerning the breeding female
- Name of this female? Age? Breed type?
- How did you acquire her (inheritance, purchase, born in the herd, others)? When (year, event, month)? From where? How old was she?
- Did she stay always within your milking herd? If not, where has she been? With whom? For how long? Why?
- What health problem did she have? What kind of treatment did you apply? Was it successful?
- Is she good, average or poor milker? How many month did you milk her last year?
- How old was she, when she delivered her first calve? How many calves did she deliver since then?
- How many abortions did she have? Before which calves? Were those early or late during pregnancy?
- Did she have difficulties to conceive? If yes, what was the reason?
- Did she reject her calve? If yes, how did you get her to accept it?
- Is she now pregnant? Or is she lactating? If yes, since how many month?
- How did she cope with the last drought?

Questions concerning each of her calves (by order of birth)
- When was the calf born (year, event, month)? Sex?
- How many month did you milk the female during this lactation?
- Did the calf survive until weaning? If not, when did it die (year, event, month)? Why?
- Where is the calf now (in your herd, slaughtered, sold, given away, died after weaning)? If disposed, when (year, event, month)? Why?
- How did it cope with the last drought?

Socio-economics

A11) Discussions in small groups: the socio-economic situation (01-03/2001)

Elders and herders at sample encampments (*olla*) (10 sessions in Dida Hara and 11 in Web, 2-5 participants)

Objectives:
- Identify demographic characteristics and development interventions
- Determine local categories of wealth
- Approximate household's livestock possessions

Guideline:
- How many households belong to your *olla*? How many households are polygamous? How many are female headed? How many households joined the *olla* recently? How many moved out recently? Why did they move in or out?
- How many cattle a household has to possess to be considered as rich, middle or poor? How many households of your olla were better-off, middle class or poor in 1997/98 (before the drought) and how many in 2001 (after the drought)?
- What types of extension service and development activities are engaged in your *olla*? Since when? By what organisation?
- What types of relief and rehabilitation activities are engaged? Since when? By what organisation?

A12) Household interviews: socio-economic baseline survey (01-03/2001)

Heads of households at sample encampments (*olla*) (182 interviews in Dida Hara and 58 in Web)

Objectives:
- Characterise the socio-economic situation of the selected encampment clusters
- Generate a base for the selection of the socio-economic in-depth assessment

Cont.: next page

Guideline:
- Name of the head of household? Name of the *olla*?
- What is the sex and age of the head of household? What is the economic status? What are additional functions? If polygamous, how many spouses belong to the head of household?
- Is the head of household originally from this area? If not, where does he/she come from? Why did he/she leave that area? When and why did he/she come into this area?
- How many persons belong to the head of household (sex and age)? Do the spouses stay in this encampment? If not, where do they stay? With how many persons?
- Who has formal education? At what type of school? Where is the school?
- Could you specify the main activities related to livestock management and crop cultivation for men, spouses and children during the severe dry-season, main rainy-season, small dry-season and small rainy-season?
- What other income generating activities besides livestock and cultivation contribute to your household and who is engaged in?
- Could you specify the activities based on mutual assistance with other households? With whom do you co-operate?
- What are the major sources of cash income and expenditures for your household? Do you get financial assistance from others or do you assist others? If yes, whom and how?
- What equipment do you possess (cropping, watering, transport, communication)?
- Do you have access to grazing reserves? If yes, with how many people do you share them? Where are they and when were they established?
- Do you cultivate crops? If yes, how big are your plots? When did you start crop cultivation?
- Is somebody of your household member in an assurance group? If yes, who? How is the mode of contributions? How many members are in the group? When did the group start operation?
- Does somebody of your household have a bank account? If yes, who? Since when?
- Did you ever sell or purchase water or grass? If yes, when and under what conditions?
- At which markets do you sell your livestock? Do you differentiate livestock categories to be sold at different markets? If yes, according to which criteria?
- How many livestock did you loose during the last drought? How many did you sell? How many did you exchange? How many survived the drought?
- What kind of extension service did you experience? Which other interventions in rangeland management did you observe and what was their impact?

A13) Household interviews: socio-economic in-depth survey (12/2001-02/2002)

Heads of households at selected encampment clusters (*ardaa*) (31 interviews in Dida Hara and 29 in Web)

Objectives:
- Determine socio-economic household characteristics and herd dynamics

Cont.: next page

Guideline:
- Household identity: Name of the head of household (sex, age)? Name of the *ardaa*?
- Consumption units and manpower: How many persons belong to the head of household (sex, age)? How many are spouses, old people, children and adopted people? Do the spouses stay in this encampment? If not, where do they stay?
- Education: Who has formal education? What degree?
- Crop cultivation: When did you start crop cultivation? How many plots do you cultivate? How far are the plots from home? How big are they?
  How much area did you cultivate this year (2001/02)? How much was left as fallow?
  The fallow area, by which type of livestock was it grazed? Who were the owners of the animals? When did they start grazing the fallow?
- Livestock husbandry: With how many households did you co-operate in group herding - during the drought (1999/2001) and after the drought (2001/02)? Do you keep dromedaries? When did you start keeping them? At what market places did you sell your livestock - during and after the drought?
- Herd flow during the drought: What was the total was the total number of animals in your herd (ca dromedaries, sheep and goats by productive category) in March 1999?
  How many were sold in the year 1999/2001? Sex? Age? Date? Price? Destination?
  How many died? Sex? Age? Date? Reason?
  How many were transferred out? Sex? Age? Date? Reason?
  How many were slaughtered? Sex? Age? Date? Reason?
  What was the total number of animals in your herd in February 2001?
- Herd flow after the drought: What was the total was the total number of animals in your herd (ca dromedaries, sheep and goats by productive category) in March 2001?
  How many were born in the year 2001/2002? Sex? Date? Twins?
  How many did you purchase? Sex? Age? Date? Price? Origin?
  How many were transferred in? Sex? Age? Date? Reason? Origin?
  How many were sold? Sex? Age? Date? Price? Destination?
  How many died? Sex? Age? Date? Reason?
  How many were transferred out? Sex? Age? Date? Reason?
  How many were slaughtered? Sex? Age? Date? Reason?
  What was the total number of animals in your herd in February 2002?
- Income: What secondary sources of income did you have 1999/2001 and 2001/02 (livestock products, livestock trade, sales in shop, petty trade, wood cutting and sale, charcoal burning and sale, goldmine, transport service, sale of grass, relief, food for work, restocking, provision of seeds, other wages, remittances, rents, etc.)? How much cash income did you receive during the year after the drought (2001/02)?
- Equipment: What additional assets did you possess during the year after the drought (2001/02) (credits given, gifts to others, bank account, tools for crop cultivation, radio, transport items, standard of dwelling, etc.)?
- Extension: What type of extension service did you experience?
- Relief: Did you receive any kind of relief during or after the drought?

Institutional development and negotiation processes

A14) Community meetings: Venn Diagrams on indigenous institutions (05-07/2001)

Elders and herders at selected PAs (1 meeting in Dida Hara and 1 in Web, 30-40 participants)

Objectives:
- Identify indigenous institutions for natural resource management
- Analyse recent changes in institutional networking
- Encourage pastoralists' capacity in analysis and self-evaluation

Cont.: next page

Guidelines:
- What are the indigenous and formal institutions which govern the access to water and pasture today and 4 *abba gadda* (32 years) ago? Could your group them in functional categories?
- Could you rank their influence on decision making by using big, middle, or small sheets?
- Could you rank the frequency by which you contact the institutions by locating the sheets with short, middle or long distance from the bottom?
- Could you demarcate the most important contacts among the institutions?
- If you compare the different pictures today and 4 *abba gadda* (32 years) ago, which differences do you observe? What are reasons for the differences?

A15) Key person interviews: pastoral oriented development (04-08/2001)

Government authorities and development experts (14 interviews)

Objectives:
- Identify the capacity of formal organisations in pastoral oriented development
- Identify potentials and constraints for IK-based natural resource management

Guidelines:
- What are the target groups of your organisation? In what areas are you operating? What are ongoing activities and what are drought induced activities? What are the main potentials and constraints for your future involvement in the Borana zone?
- What changes in government priorities, land tenure arrangements and land use patterns did you observe over time?
- What is the impact of the following development interventions on natural resource management in the Borana zone: water development, rangeland development, ban on burning the range, formal government, extension service, marketing, crop cultivation, formal education, income diversification, new administrative borders, relief and rehabilitation?
- What are the indigenous procedures of allocating water and rangeland resources? What are main conflicts in pastoral natural resource management? How can they be solved?
- What is the impact of social stratification within Borana communities? How can the wealthy Borana herd owners contribute to sustainable pastoral development?
- What is the role of the local communities in planning and implementing new technology?
- Is the indigenous rangeland and water management system still applicable? What do you recommend for a successful integration of indigenous and formal governance?
- What are the potentials and constraints of mobile land use including forra (seasonal grazing areas)?
- What are the potentials and constraints of herd diversification?
- According to your view, what measures should be taken to improve Borana rangeland conditions?

A16) Final meetings: multi-stakeholder workshops (06-07/2002)

16a) at community-level: elders, herders and women (1 meeting in Dida Hara and 1 in Web);
16b) at regional and national-level: representatives from communities, NGOs, research-, development- and government- organisations (1 meeting in Negelle, 1 in Yabello, 1 in Addis Ababa)

Objectives16a and 16b:
- Feed back to communities and development agents
- Cross check of research findings in field
- Encourage ongoing process of participatory pastoral development

Cont.: next page

Guideline 16a:
- Welcome and presentation of the study approach and preliminary findings
- What are the main problems in pastoral oriented rangeland and water management?
- What are root causes for the identified problems?
- Could you formulate proposals of how to solve these problems?

Guidelines 16b:
- Welcome and presentation of the study approach and preliminary findings
- What is the value of pastoralists' IK for rangeland and water development?
- What are the major constraints to make use of pastoralists' IK?
- Could you formulate the priorities for a pastoral oriented development process?

Quantitative technical assessments

A17) GPS survey (05/2001)

Local range scouts at selected encampment clusters (*ardaa*) (3 surveys in Dida Hara and 3 in Web)

Objectives:
- Measure current land use categories at the level of encampment clusters

Guideline:
- What are the borders of your *ardaa*? What are the borders of *kallos* (fodder banks) and cultivated fields? Where are villages, ponds, watering cisterns, main pathways for transit herds?
- Where are the main newly constructed water ponds in Dida Hara?

A18) Cattle body weight and breeding type survey (02/2002; 06/2002)

Heads of households of selected encampment clusters (390 cattle in Dida Hara and 153 in Web)

Objectives:
- Characterise local breeding types of cattle, goats and dromedaries by sex, age and seasonal body weight

Guideline:
- What is the type of the cattle (*qorti* or *ayuna*?)? Is she pregnant?
- Could we measure his/her body weight?

A19) Water and salt analysis (05/2002)

Wells (3 in Web and Higgo), ponds (3 in Dida Hara), salt (7 different sources)

Objectives:
- Analyse chemical composition of different water and salt sources

Guideline:
- Stratify the different water and salt sources
- Take samples and transfer for chemical analysis to ILRI laboratory Addis Ababa

ATable 2. Criteria selected to categorise households as low, medium or high in herd mobility during and after the drought.

Categories of herd mobility	During drought	After drought
Low mobility		
Threshold	< 11 km	< 2 km
Middle mobility		
Threshold	11 – 35 km	2 – 24 km
Additional requirements	+ cattle moved	+ cattle moved
Highly mobility		
Threshold	> 35 km	> 24 km
Additional requirements	+ cattle moved + shifted the herd twice	+ cattle moved + shifted the herd twice

ATable 3. Frequency of mobility (% of households) measured in Dida Hara and Web during and after the last drought.

Mobility	Dida Hara		Web	
	During drought	After drought	During drought	After drought
	[%]			
Low mobility	39	81	31	31
Medium mobility	48	19	48	48
High mobility	13	0	21	21

ATable 4. Demographic characteristics (n) and human population density (n km^{-2}) measured between selected encampment clusters in Dida Hara and Web.

Demographic characteristics	Dida Hara			Web		
	Danballa Abba Chana	Dambi	Dikale	Kukub Y'aa	Daka Guracha	Nana
	[n]					
Encampments[1]	5	10	15	5	5	3
Households[1]	196	265	327	35	22	48
Female headed households[1] (%)	58 (30)	26 (10)	38 (12)	5 (14)	2 (9)	11 (23)
Polygamous households[1] (%)	15 (8)	14 (5)	11 (3)	0 (0)	2 (9)	3 (6)
Human population[2]	1363	1805	1975	240	125	367
People per households[2]	6.8	6.8	6.0	6.9	5.7	7.7
Human population density[2]	35	27	14	32	8	58

[1] Source: Discussions in small groups on the socio-economic situation (A11 in ATable 1).
[2] Source: Socio-economic baseline survey (A12 in ATable 1).

ATable 5. Estimated average stocking densities (TLU km^{-2}) and coefficients of variation (%) measured for total stocking densities during a year before and after the drought between selected encampment clusters of Dida Hara and Web.

Encampment cluster	Long dry-season (Dec-Feb)	Long rainy-season (Mar-May)	Short dry-season (Jun-Aug)	Short rainy-season (Sep-Nov)	Means	CV
	[TLU km^{-2}]					[%]
Before drought (1997/98)						
Dida Hara						
Danballa Abba Chana	77.5	63.1	63.1	63.1	66.7	10.8
Dambi	23.1	23.1	23.1	23.1	23.1	0
Dikale	27.8	13.0	16.9	17.4	18.8	33.5
Average cluster	42.8	33.1	34.4	34.5	36.2	12.4
Web						
Kukub Y'aa	819.3	251.3	315.5	265.2	412.8	66.0
Daka Guracha	78.3	23.6	43.6	11.7	39.3	74.3
Nana	116.9	29.1	83.4	38.6	67.0	60.9
Average cluster	338.2	101.3	147.5	105.2	173.0	66.0
TOTAL					104.6	
After drought (2001/02)						
Dida Hara						
Danballa Abba Chana	27.6	27.6	27.6	27.6	27.6	0
Dambi	13.6	13.6	13.6	13.6	13.6	0
Dikale	4.9	4.9	4.9	4.2	4.9	6.1
Average cluster	15.4	15.4	15.4	15.1	15.3	0.7
Web						
Kukub Y'aa	162.2	9.3	194.1	9.3	93.7	104.9
Daka Guracha	39.1	9.5	45.5	4.9	24.8	83.1
Nana	151.7	67.9	134.9	13.1	91.9	69.4
Average cluster	117.7	28.9	124.2	9.1	70.1	86.9
TOTAL					42.7	

ATable 6. Land use categories (ha) between selected encampment clusters in Dida Hara and Web.

Land use category	Dida Hara			Web		
	Danballa Abba Chana	Dambi	Dikale	Kukub Y'aa	Daka Guracha	Nana
	[ha]					
Crop cultivation	262	290	311	38	28	72
(%)	(7)	(4)	(2)	(5)	(2)	(12)
Forage-bank	527	924	1190	111	97	98
(%)	(14)	(14)	(9)	(15)	(6)	(15)
Common grazing	3,103	5,363	12,260	602	1,408	456
(%)	(79)	(82)	(89)	(80)	(92)	(73)
Total land	3,891	6,578	13,761	752	1,533	626
(%)	(100)	(100)	(100)	(100)	(100)	(100)

Data based on GPS measurements

ATable 7. Water sources by chemical composition.

Water source	pH	Ca	Mg
Web wells	7.0-7.1	96-107	10
Higo wells	6.8-6.9	68-71	10
Haro Bakke pond	7.2	21	4

Data own sampling, analysed by ILRI-Ethiopia analytical services laboratory (available Ca and Mg in mg l^{-1}).

ATable 8. Natural salt supplements by pastoralists' characterisation and chemical composition.

Type	Live-stock species	Feeding time	Palata-bility	Benefit	Mineral content				
					P	Na	K	Ca	Mg
Extracts from volcanic craters									
Dillo	all species	start of rainy-season	good quality	meat, strength, health	52	24	1	52	3
Hacharu Chulki	mainly cattle, also goats	any time, preferably at start of rainy-season	best quality, high salt content, mixed with *haya*	bones, strength	27	2	6	2	0
Doqe	mainly cattle, also dromedaries	any time, preferably ongoing rainy-season	medium quality, mixed with *haya*	meat, fertility	43	3	0	5	0
Magado	mainly goats	entire rainy-season	best quality, mixed with *haya*	health, milk	74	3	0	1	7
Qula	all species	any time	lower quality	health, strength	63	3	2	2	0
Complementary salty soil									
Haya (Ru-kessera) *	all species	any time	important supplement	fattening, health	10	3	0	3	0
Haya (Ess) *	all species	any time	important supplement	fattening, health	9	29	0	4	18

Data from community discussions, and own sampling analysed by ILRI-Ethiopia analytical services laboratory (available P in ppm and Na, K, Ca, Mg in meq $100g^{-1}$).
* Location of collecting the sample.

ATable 9. Indigenous functional livestock categories compiled for cattle, small ruminants and dromedaries.

Local name	Age (years)	Sex	Physiological status and functional aspects
Cattle			
Waatiyee	0 – 0.5	Both	Suckling calve, feed at home for at least 3 month
Yaabiye adele	0.5 – 1	Both	Growing calve, start grazing near home and in *kallo*
Yabiye agoro	1-2	Both	Weaner, graze far and in *kallo*, drink up to 3. day, separate group from big cattle
Lamacha	3	Both	Big calve, graze and drink with big cattle
Jibicha	0-2	Male	Calves, distinguished by sex
Qotiyo	3-5	Male	Trained for ploughing, preferably uncastrated, should not give service at the same time, highest performance at 5 years
(Jibicha) kurkurra	3-4	Male	Intact, to test for service
(Jibicha) mirgoo	4-5	Male	Castrated, for fattening
(Jibicha) korma	4-5	Male	Breeding bull until service
Kormaa	6-10	Male	Breeding bull in full service
Korma dulascha	>10	Male	Old breeding bull
Sangaa	6-8	Male	Bullock for fattening
Sangaa bulessa	9-11	Male	Very fat bullock
Sanga dulatscha	>11	Male	Very old bullock
Qubla	6-7	Male	Late castration, proved unproductive for breeding
Raada	0-2	Female	Calves, distinguished by sex
Goromsa	3-5	Female	Conception-first parturition, in satellite herd
Hawicha/saa	6-12	Female	Milking cow, 1-6 parturition, at residence
Dulacha	>12	Female	Milking cow of > 6 parturition, in menopause
Macena		Female	Unfertile for fattening
Dankaka		Female	No sex organs, refuse bull, for fattening
Guessa		Female	Dry cow for satellite herd
Goats			
Korbessa didiko	0-0.5	Male	Suckling male kid, feed at home for at least 1 month
Korbessa karota	0.5-1	Male	Weaner, graze with the herd
Korbessa finchandande	1-1.5	Male	Intact bock, to test for service
Korbessa korma	1.5-7	Male	Breeding bock
Korbessa jarki	>6	Male	Old breeding bock
Korbessa mirgoo / tumalessa	1-2	Male	Castrated, for fattening
Korbessa qobole	3-6	Male	Castrated, best selling age
Korbessa qubla	4-5	Male	Late castration, proved unproductive for breeding
Ilme didiko	0-0.5	Female	Suckling female kid, feed at home for at least 1 month
Ilme gudo	0.5-1	Female	Weaner, graze with the herd
Goromti	1-2	Female	Doe, conception-first parturition
Hawiti goromti	3-5	Female	Doe, 1-3 parturition
Hawiti chimeti	6-8	Female	Doe, 4-6 parturition
Hawiti dulati	>8	Female	Doe, >6 parturition, in menopause
Dankaka		Female	No sex organs, refuse bock
Macena		Female	Unfertile, for fattening

Cont. next page

Sheep			
Elemo	0-0.9	Male	Suckling male lamb, feed at home for at least 1 month, weaning after 6 month
Korma	1-5	Male	Ram
Mirgoo / tumalessa	1-4	Male	Castrated, preferably at the age of 2 years
Sangaa	5-6	Male	Castrated
Dulascha	7-8	Male	Old male
Qubla	>5	Male	Late castration, proved unproductive for breeding
Ilme	0-0.3	Female	Suckling female lamb, feed at home for at least 1 month, weaning after 6 month
Karso	>0.9	Female	Doe, conception-first parturition
Hawicha goromsa	-1-2	Female	Doe, 1-3 parturition
Hawicha chimessa	3-5	Female	Doe, 4-6 parturition
Hawicha dulacha	>6	Female	Doe, >6 parturition, in menopause
Rupe		Both	Calves of stagnant growing
Dankaka		Female	No sex organs, refuse ram
Macena		Female	Unfertile, for fattening
Dromedaries			
Jibicha	0-3	Male	Calf, feed at least 0.5 month
Rocho	4-6	Male	Intact bull, to test for service
Korma	>6	Male	Breeding bull
Korma dulatscha	>14	Male	Old breeding bull
Mirgoo	5-8	Male	Castrated
Sanga	9-12	Male	Castrated, matured
Sanga dulatscha	>14	Male	Old castrated
Qubla	>8	Male	Late castration, proved unproductive for breeding
Orge	0-3	Female	Calf
Goromsa	4-5	Female	Conception-first parturition
Hawicha/ala	>5	Female	Milking cow
Hawicha/ala dulati	>18	Female	Old cow, in menopause
Macena		Female	Unfertile
Dankaka		Female	No sex organs, refuse bull

ATable 10. Performance of the Ethiopian Boran cattle breed compiled in comparison to the Improved Boran cattle breed according to different authors.

Authors	Characteristics (means or ranges)								
	Birth weight	Adult live weight		Age first partu-rition	Partu-rition interval	Partu-rition rate	Total milk off-take	Lacta-tion length	Daily milk yield
		♂	♀						
	[kg]	[kg]	[kg]	[months]	[days]	[%]	[l]	[days]	[l]
Ethiopian Boran cattle breed									
ILRI (2003)		259-680		35-52	334-420		454-1814	139-313	
Rege (1999)*		300-385	300-350						
FAO, DAD-IS (1995)	18-23	318	225	48-60	334-420	75	843	210	3,5
Osuji *et al*. (1995)*			285-291						2,8-3,4
Coppock (1994)		400	225	48-54	420-450		850	320	2,6
Tegegne *et al*. (1992)			363-388						1,0-3,3
Maule (1990)*			225-250						
Nicholson & Little (1989)*			256-471						
Haile-Mariam (1987)*	25,2			45					
Nicholson & Cossins (1984)*		700	445						
Kebede (1983)*				36-35	465	94	854	305	
Improved Boran cattle breed									
Rege (1999)*		550-850	400-550						
Herring *et al.* (1996)*	40								
Kassouta (1992)				42	544				
Maule (1990)*		550-850	400-850				860-1090	213-234	
Trail *et al*. (1985)			286	47	477	75			
Gregory *et al*. (1984)*				35	412				
Thorpe & Cruik-shank (1980)*						88			
Were *et al*. (1972)*	26-29		337-396			55-76			

*Source: http://DAGRIS.ilri.cgiar.org/traitsbysource; cont. next page

ATable 11. Performance of goats, sheep and dromedaries compiled for pastoral systems similar to the Borana system according to different authors.

Authors	Characteristics (means or ranges)								
	Birth weight	Adult life weight		Age at first partu-rition	Partu-rition interval	Partu-rition rate	Total milk off-take	Lacta-tion length	Daily milk yield
		♂	♀						
	[kg]	[kg]	[kg]	[months]	[days]	[%]	[l]	[days]	[l]
				Goats					
DAGRIS*	2.4	35							
FARM Africa (1996)		41							
Cossins & Upton (1987)				16.8			47		
				Sheep					
DAGRIS*	2.7		31.7						
Cossins & Upton (1987)				18					
				Dromedaries					
Kaufmann (1998)		450-650	350-575	59-67	27-28	34-39	320-2760	9-15	0.8-10.9

*Source: http://DAGRIS.ilri.cgiar.org/traitssum

ATable 12. Means, modes and standard errors for milk production (l) estimated for cattle, goats and dromedaries (progeny history data).

Milk production	Sample [n]	Means (Min-Max) [l]	Modes	se
Cattle	453	1.1 (0.3-3.0)	0.6	2.9E-02
Goats	216	0.4 (0-1.5)	0.3	1.9E-02
Dromedaries	180	1.7 (0.3-4.5)	1.5	6.1E-02

ATable 13. Means, modes and standard errors of lactation length (month) estimated for cattle, goats and dromedaries (progeny history data).

Lactation length	Sample [n]	Means (Min-Max) [month]	Modes	se
Cattle	435	10.0 (0.3-24)	12	0.3
Goats	214	2.4 (0-24)	1	0.2
Dromedaries	177	12.6 (1-24)	12	0.4

ATable 14. Means (minimum and maximum values), modes and standard errors of age of first parturition estimated for cattle, small ruminants and dromedaries kept (months) (progeny history data).

Parturition age	Sample [n]	Means (Min-Max) [month]	Modes	se
Cattle	453	54.8 (48-96)	48	0.4
Goats	217	28.3 (12-72)	24	0.7
Dromedaries	183	61.1 (48-108)	60	0.7

ATable 15. Means (minimum and maximum values), modes and standard errors of parturition interval estimated for cattle, small ruminants and dromedaries kept (months) (progeny history data).

Parturition interval	Sample [n]	Means (Min-Max) [month]	Modes	se
Cattle	454	19.4 (9.1-84.2)	12.2	0.4
Goats	256	13.8 (5.1-68.0)	12.2	0.4
Dromedaries	200	27.0 (10.2-68.0)	13.2	0.9

ATable 16. Means (minimum and maximum values), modes and standard errors of age of breeding females estimated for cattle, small ruminants and dromedaries kept (months) (progeny history data).

Age	Sample [n]	Means (Min-Max) [month]	Modes	se
Cattle	454	86.4 (48-204)	84	1.0
Goats	217	54.4 (24-120)	48	1.3
Dromedaries	183	111.9 (48-216)	120	2.6

ATable 17. Means, modes and standard errors of number of calves born (n) per breeding female estimated for cattle, goats and dromedaries (progeny history data).

Calves born	Sample	Means (Min-Max)	Modes	se
	[n]			
Cattle	453	2.2 (0-9)	2	5.79E-02
Goats	217	2.6 (1-9)	2	9.02E-02
Dromedaries	183	2.4 (0-6)	2	9.91E-02

ATable 18. Frequencies of parturition per breeding female (%) estimated for cattle (n = 453), goats (n = 217) and dromedaries (n = 183) at different stages of productive age (progeny history data).

Parturition	Cattle	Goats	Dromedaries
	[%]		
< 3 calves	87	79	77
4-6 calves	12	20	23
> 6 calves	1	1	0

ATable 19. Destinations of offspring (%) estimated for cattle (n = 453), goats (n = 217) and dromedaries (n = 183) (progeny history data).

Destination of offspring	Cattle	Goats	Dromedaries
	[%]		
Death	60	54	76
Sale	32	30	15
Slaughter	4	9	2
Gift	4	6	5
Loss	0	0	2
Theft	0	1	0

ATable 20. Causes of mortality (%) of offspring estimated for cattle (n = 453), goats (n = 217) and dromedaries (n = 183) (progeny history data).

Cause for mortality	Cattle	Goats	Dromedaries
	[%]		
Disease	24	30	69
Drought	64	53	25
Predator	6	17	5
Accident	2	0	0

ATable 21. Frequency of abortions (%) estimated for cattle (n = 453), goats (n = 217) and dromedaries (n = 183) (progeny history data).

Frequency of abortion	Cattle	Goats	Dromedaries
	[%]		
Abortion rate	4	3	9
Females with abortion	8	8	19

ATable 22. Origin of breeding females (%) estimated for cattle, goats and dromedaries (progeny history data).

Origin	Sample [n]	Born	Purchase	Gift	Looting
		----------[%]----------			
Cattle	453	72	6	21	1
Goats	217	52	20	27	1
Dromedaries	183	56	34	7	3

ATable 23. Breeds of females (%) estimated for cattle, goats and dromedaries (progeny history data).

Breeds	Sample [n]	Boran	Somali	Gabbra	Gujji	Konso
		----------[%]----------				
Cattle	453	95	3	1	1	0
Goats	217	92	1	1	1	5
Dromedaries	183	66	22	12	0	0

ATable 24. Standardisation applied to consumption units.

Sex and age group	African Adult Male Equivalent (AAME)
Males and females, 0-5 years	0.52
Males and females, 6-9 years	0.85
Males and females, 10-15 years	0.96
Males, 16-60 years	1.0
Females, 16-60 years	0.86

ATable 25. Standardisation applied to manpower.

Sex and age group	Labour Supply Units (LSU)
Males and females, 6-9 years	0.45
Males and females, 10-15 years	0.85
Males and females, 16-60 years	1.0
Pupils	0.35
Males and females, > 65 years	0.65

ATable 26. Livestock markets which have been frequented by the sample households and their functional category.

Functional category	Definition	Market locations
Local market	Congregate to exchange livestock, on barter or cash basis	Dida Hara Web
Primary market	First point where stock enter trade, along livestock routes, all kinds of purchasing objectives, dealers present	Metagarfarsa, Yabello, Surupa, Finchawa, Harobacke
Secondary market	Largest markets along stock routes leading to final destinations on all-weather roads, exchange of livestock between local and larger traders	Dubuluq
Export market	In border regions, also attended by pastoralists	Moyale

ATable 27. Standardisation applied to equipment by their amount and local peculiarity.

Items	Number of items	Weighing factor
Individual water cistern	1	6
Bank account	1	6
House for rent	1	6
House for trade	1	4
Dromedaries for transport	> 4	3
	2-3	2
	1	1
Equines for transport	> 4	3
	2-3	2
	1	0.5
Ploughs	> 5	1,5
	2-4	1
	1	0.5
Pairs of draught animals	> 5	1,5
	2-4	1
	1	0.5
Radio	1	1
House with sale of drinks	1	1
Save and credit group	1	1

ATable 28. Mean mortality rates during the drought (%) and net herd growth rates after the drought (%) measured for selected herds in Dida Hara and Web (n=60).

	Mortality rates		Net herd growth rates	
	Mean	se	Mean	se
	[%]			
Cattle	53.95	2.67	27.14	7.37
Small ruminants	28.65	3.82	14.71	8.50
Dromedaries	29.59	4.98	12.86	6.26

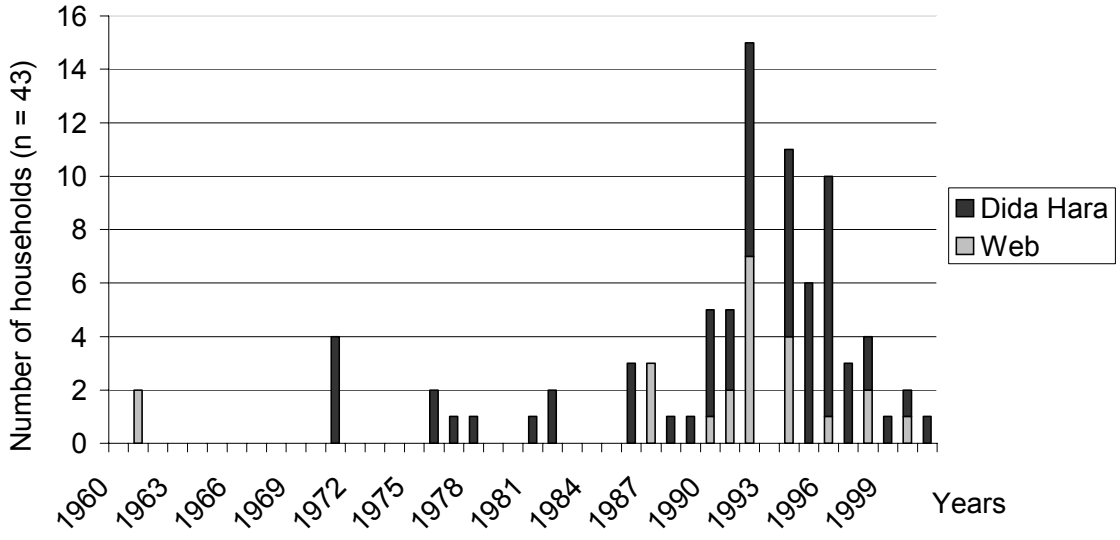
ATable 29. Mean outflow rates (%) for cattle, small ruminants and dromedaries measured for selected herds in Dida Hara and Web during and after the drought (n=60).

	Dida Hara		Web	
	During drought	After drought	During drought	After drought
	[%]			
Cattle				
Sale	16 (2.1)	16 (4.5)	17 (2.0)	30 (3.0)
Death	60 (3.8)	2 (1.0)	47 (3.4)	5 (2.0)
Gift	0.1 (0.1)	1 (1.0)	0.4 (0.2)	2 (1.0)
Slaughter	0	0.1 (0.1)	0	3 (1.2)
Small ruminants				
Sale	28 (4.1)	12 (2.4)	20 (4.0)	14 (3.1)
Death	15 (3.4)	16 (5.0)	44 (6.0)	9 (3.9)
Gift	0.4 (0.3)	10 (4.0)	0	3 (1.4)
Slaughter	0	2.13 (1.1)	0	10 (4.9)
Dromedaries				
Sale	22 (7.6)	0.4 (0.4)	11 (5.1)	9 (4.5)
Death	23 (7.8)	2 (1.7)	41 (6.4)	6 (3.3)
Gift	9 (9.1)	0.4 (0.4)	0	0
Slaughter	0	0	0	0

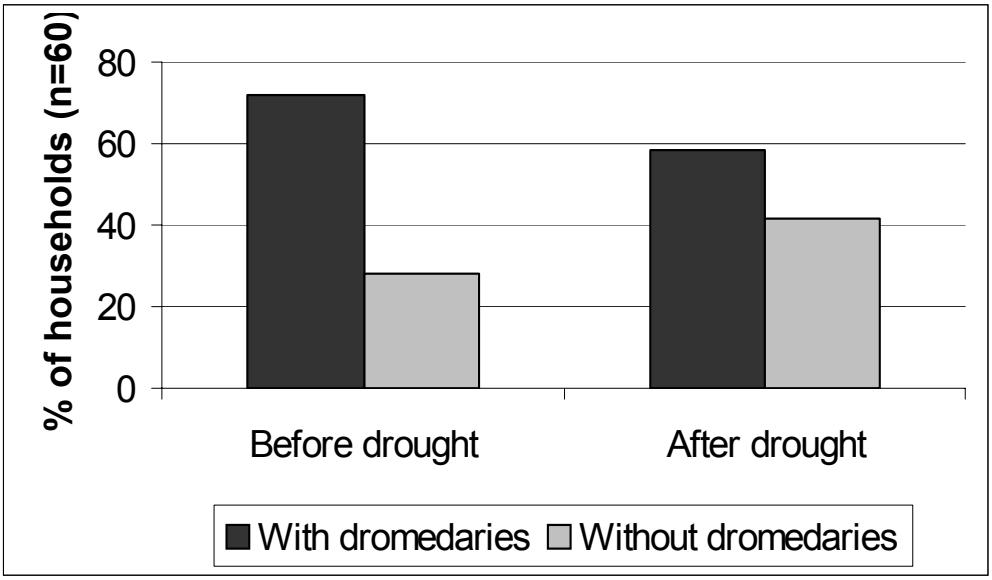
ATable 30. Mean inflow rates (%) for cattle, small ruminants and dromedaries measured for selected herds in Dida Hara and Web during and after the drought (n=60).

	Dida Hara		Web	
	During drought	After drought	During drought	After drought
	[%]			
Cattle				
Birth	0	59 (8.7)	0	35 (3.5)
Purchase	0	2 (1.2)	0	0.5 (0.3)
Gift	0	16 (5.8)	0	2 (1.7)
Small ruminants				
Birth	0	45 (7.1)	0	40 (6.5)
Purchase	0	2 (1.0)	0	0
Gift	0	13 (5.9)	0	0.8 (0.8)
Dromedaries				
Birth	0	31 (7.3)	0	14 (6.5)
Purchase	0	0	0	0.2 (0.2)
Gift	0	5 (4.6)	0	0

AFIGURES



AFigure 1. Start of keeping dromedaries in Dida Hara and Web.



AFigure 2. Frequency of households adopting dromedaries in Dida Hara and Web before and after the drought.

ABOXES

Parameter estimation applied on the application of mobility, Y_1.			
Explanatory variables	Estimated coefficient	Significance	se
Human support capacity = below	0.905	0.146	0.624
Human support capacity = above	0	.	.
Marketing level = no market	-3.717	0.003	1.263
Marketing level = regional market	-3.249	0.001	1.010
Marketing level = export market	0	.	.
Extension = not	-0.743	0.172	0.544
Extension = yes	0	.	.
Model information:	n = 60; -2log-likelihood, final model general = 35.299; $\chi 2$ = 14.786, significant at 0.005; df = 4		
Goodness of fit measures:	Pearson's $\chi 2$ = 11.443, significant at 0.651; Deviance = 13.765, significant at 0.467; df = 14		
Pseudo R squares:	Cox & Snell = 0.218; Nagelkerke = 0.251; McFadden = 0.121		
% correctly predicted counts: (high mobility).	63.33 (total); 66.66 (low mobility), 68.97 (medium mobility); 40.00		

ABox 1. Ordinal regression model applied on households' determinants for mobility during the drought.

Parameter estimation applied on the application of mobility, Y2.			
Explanatory variables	Estimated coefficient	Significance	se
Location = Dida Hara	-2.702	0.001	0.797
Location = Web	0	.	.
Co-operation = no group	-2.846	0.008	1.079
Co-operation = small group	-1.150	0.253	1.006
Co-operation = large group	0	.	,
Human support capacity = below	-4.262	0.000	1.175
Human support capacity = above	0	.	.
Adoption of dromedaries = with	-0.904	0.235	0.761
Adoption of dromedaries = without	0	.	.
Model information:	n = 60; -2log-likelihood, final model general = 39.754; $\chi 2$ = 48.788, significant at 0.000; df = 5		
Goodness of fit measures:	Pearson's $\chi 2$ = 44.906, significant at 0.017; Deviance = 29.955, significant at 0.316; df = 27		
Pseudo R squares:	Cox & Snell = 0,557; Nagelkerke = 0,662; McFadden = 0,443		
% correctly predicted counts:	83.33 (total); 94.11 (low mobility), 80.00 (middle mobility); 33.33 (high mobility).		

ABox 2. Ordinal regression model applied on households' determinants for mobility after the drought.

Parameter estimation applied on the adopt dromedaries, Y_3.

Explanatory variables	Estimated coefficient	se	Significance
Human support capacity	2.441	0.788	0.002
Constant	6.778	47.249	0.886
Consumption units			0.963
Consumption units = small	-10.259	47.246	0.828
Consumption units = middle	-10.379	47.246	0.826
Model information:	n = 60; -2Log-likelihood, final model general = 52.582;		
Goodness of fit measures	Omnibus test of the coefficients: χ^2 = 18.947, significance = 0.000		
Hosmer Leemeshow test:	χ^2 = 0.468, significance = 0.977		
Pseudo R^2:	Cox and Snell = 0.271; Nagelkerkes = 0.389.		
% correctly predicted counts:	81.7 (total); 52.9 (no dromedaries); 83.7 (with dromedaries).		

ABox 3. Logistic regression model applied on households' determinants for the adoption of dromedaries before the drought.

Parameter estimation applied on the adopt dromedaries, Y_4.

Explanatory variables	Estimated coefficient	se	Significance
Equipment	11.215	66.093	0.865
Constant	-1.272	97.825	0.990
Consumption units			0.174
Consumption units = small	-9.624	72.121	0.881
Consumption units = middle	-10.830	72.121	0.881
Model information:	n = 60; -2Log-likelihood, final model general = 54.839;		
Goodness of fit measures	Omnibus test of the coefficients: χ^2 = 26.664, significance = 0.000		
Hosmer Leemeshow test:	χ^2 = 0.000, significance = 1.000		
Pseudo R^2:	Cox and Snell = 0.359; Nagelkerkes = 0.483.		
% correctly predicted counts:	75.0 (total); 68.0 (no dromedaries); 80.0 (with dromedaries).		

ABox 4. Logistic regression model applied on households' determinants for the adoption of dromedaries after the drought.

1) Main problems

- 1a) weakening of the indigenous institutions
- 1b) alienation of rangeland and water by the Ethiopian regionalisation policy

2) Root causes

- 2a) for the weakening of indigenous institutions
  - interference by the formal administration (*PA*)
  - conflicts between generations and wealth groups
  - corruption, alcool
- 2b) for the shrinkage of rangeland resources
  - historical marginalisation of Borana pastoralists
  - alienation of rangeland and water by the Ethiopian regionalisation policy
  - implementation of ranches
  - pressure from neighbouring ethnical groups
  - expansion of crop-cultivation and private grazing
  - woody species encroachment and land degradation
  - human population growth

3) Solutions derived

- 3a) for the integration of Borana pastoralists' IK and modern administration
  - transfer of authority in rangeland and water management to the Borana communities, including planning and evaluation of technology/institutional development
  - initiate negotiations with formal administration at the local-level (PA)
  - minimise the role of the formal administration (woreda) to facilitate sustainable natural resource management
  - involve development actors (NGO's etc.) for facilitation, information transfer and backstopping
  - define a clear task description for all stakeholders in pastoral development and co-ordinate the development activities
  - improve the understanding and recognition of Borana management strategies and sensitise for respect of the Borana culture
  - start joint efforts for the elimination of corruption and combat the problem of alcohol
  - re-integrate wealthy herd owners into the pastoral management systems
  - improve income diversification, investment opportunities, marketing facilities and formal education
  - create a forum for sharing experience, derive practical recommendations, and promote multi-sectoral development approaches.
- 3b) for sustainable rangeland and water management
  - revitalise indigenous institutions and awareness creation
  - acknowledge rangeland and water resources as a property of Borana pastoralists
  - support reconciliation between ethnical groups
  - transfer the ranches back to the Borana communities
  - strengthen conflict mediation and solving within and between pastoral communities
  - preserve seasonal rangeland categories (foora) and herd mobility
  - control the allocation of encampments
  - support woody species control by selective burning
  - restrict crop cultivation on limited areas
  - prohibit private grazing
  - support family planning by reinforcing the rules for marriage and breast feeding.

ABox 5. Main issues discussed at the multi-stakeholder workshops with representatives from the Ethiopian government, Non Governmental Organisations, international research and development institutions and pastoral communities.

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CURRICULUM VITAE

Personal data

Name:	Sabine Homann
Place of birth and date:	Lüdinghausen, 11th of April 1970
Nationality:	German
Marital status:	Single, one daughter

Education and employment record

08/2002 – 12/2004	Preparation of the Dissertation at the Department of Livestock Ecology, Justus-Liebig-University Giessen, Germany.
10/2000 – 07/2002	Field research work in Borana rangelands, southern Ethiopia, supported by the Tropical Ecological Support Programme (TOEB/GTZ) and the Borana Lowlands Pastoral Development Programme (BLPDP/GTZ).
05/1999 – 09/2000	Research proposal and preparation of the dissertation research at the Institute of Cop and Animal Production in the Tropics and Subtropics, Georg-August-University, Goettingen, Germany.
1990 - 1997:	Studied agricultural sciences at the Georg-August-University, Goettingen, Germany: Diplom (MSc. agr.).
1981 - 1989	Attended secondary education at Gymnasium Canisianum, Lüdinghausen, Germany.

Working experiences

05/1996 – 08/1996	Hospitation in Hereroland, Namibia, supported by the Sustainable Animal and Range Development Programme (SARDEP/GTZ): Study on the use of livestock farmers' IK for sustainable rangeland management development.
10/1995 – 12/1995:	Practical training at GTZ, Eschborn: Literature study on pastoral systems in Africa and the traditional regulation of access to key resources.
06/1997 – 07/1997, 07/1995 – 10/1995 :	Research fellow at the Institute of Cop and Animal Production in the Tropics Subtropics, Georg-August-University Goettingen: Literature research on farming systems approaches and modelling.
07/1994 – 09/1994:	Practical training at the Association for Solidarity World (ASW), Westafrica department, Berlin.
10/1992 – 07/1993:	Practical training at several NGO's in Senegal.
06/1991 – 08/1991:	Practical training at a bio-organic farm, Bath, England.
08/1989 – 07/1990:	Practical training at a vocational farm, Coesfeld, Germany.

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