Pastoral mobility as a response to climate variability in African drylands

Hanne Kirstine Adriansen

Abstract

The article outlines aspects of 'the new paradigm' for dryland ecosystems and pastoral production systems. Rationality of pastoralism was claimed by parts of the research community for decades, but especially among policy and development planners pastoralism was perceived as an irrational and destructive production system. With the new paradigm a coherent theory is provided linking the dynamics of drylands with pastoral strategies. Consequences of the new paradigm are analysed from a theoretical point of view, emphasis is on implications for pastoral mobility with a focus on pastoral systems in West Africa. In an example from Ferlo, Senegal, different types of pastoral mobility are discussed with special focus on the importance of scale. It is concluded that pastoral mobility is a rational response to climate variability and unpredictability in African drylands.

Keywords

Drylands, pastoralism, pastoral mobility, climate variability, Africa, Senegal.

Hanne Kirstine Adriansen: Institute of Geography, University of Copenhagen, Øster Voldgade 10, 1350 Copenhagen K., Denmark. E-mail: ha@geogr.ku.dk.

Geografisk Tidsskrift, Danish Journal of Geography
Special Issue, 1: 1-10, 1999

The Sahel has been a region of research interest for the Institute of Geography, University of Copenhagen, for the last two decades. Here, as in many other parts of research and donor communities, the drought years in the beginning of the 1970's were the point of departure for efforts trying to understand the interacting human end environmental problems of the region. Emphasis has been on land degradation, agricultural systems, and changes in land use (Reenberg 1982) often using satellite remote sensing as a tool (Reenberg 1987, Rasmussen & Reenberg 1992, Reenberg 1994). The institute has since 1987 been engaged in close collaboration with the Senegalese institution Centre de Suivi Écologique (CSE), funded by DANIDA through UNSO. The collaboration has been focussed on monitoring of biomass production using satellite imagery (e.g. Rasmussen 1998a). This has included both yield estimations and monitoring of pastoral resources in the Ferlo region of Senegal (Rasmussen 1998b, in this volume). Lately, this has been expanded into a broader study of pastoral strategies, and the present paper should be seen in this context.

Within the past ten years our understanding of the functioning of dryland ecosystems and production systems in these areas has changed. The implications of droughts and development are being reinterpreted and a new paradigm and new methods established. The new paradigm, which has been called the 'state-and-transition' paradigm (Westoby et al. 1989) or 'instability-but-persistence' paradigm (Warren 1995), is the basis for this article.

The paradigm shift happened gradually and anomalies leading to it occurred in different disciplines at the same time. However, as outlined in next section, it seems that the new thinking in range ecology was more influential for thinking in pastoral systems than vice versa. The implication of the new paradigm for dryland ecosystems and pastoral production systems has been discussed elsewhere (e.g. Ellis & Swift 1988, Westoby et al. 1989, Warren 1995). Hence, the purpose of this article is to take the discussion a bit further and consider implications of

the new paradigm for one particular aspect of pastoral production systems, namely for the pastoral mobility.

The article will be divided into three main sections; the first concerns the new view on dryland ecosystems and on pastoral production systems in drylands. In the second section 'old ideas' of pastoral mobility are mentioned before a discussion of implications of the new paradigm for pastoral mobility. Finally, the third section is an example from Ferlo, Senegal. It is illustrated how a development project based on the old paradigm affected pastoral mobility, and how the pastoralists themselves use mobility for balancing variability in natural resources as advocated by the new paradigm.

A new view on dryland ecosystems and pastoral production systems

About two-thirds of the African continent consist of arid or semi-arid areas, whereas the figure for the world in general is one-third. Traditionally, production systems in these areas have been pastoral, some supplemented with extensive agricultural production, or the areas have been utilised by hunters and collectors. In some areas production systems have undergone radical changes within the past centuries, while utilisation of other areas has hardly changed for centuries even millenniums. Tropical dryland ecosystems all over the world display similarities, but the production systems vary. While the new view on dryland ecosystems is universal, the discussion in this article of production systems mainly applies to Africa.

Dryland ecosystems

For decades the basis for studying dryland ecosystems in Africa as well as in Australia and USA was Clements' model of vegetation succession (Clements 1916), the idea of equilibrium ecosystems, and livestock density dependent limitations of primary production (Deshmukh 1986). According to Clements, vegetation changes are deterministic series of vegetation types ending with a vegetation climax community. The climax community may fluctuate in composition, but it will remain relatively unchanged over long periods. Grazing pressure produces vegetation changes in a direction opposite to the succession tendency. Therefore, a vegetation equilibrium can be produced by setting the stocking rate, and thus grazing pressure, at a level equal to the natural vegetation succession tendency (Westoby et al. 1989). Implicit in the model is the idea of equilibrial ecosystems; from an equilibrial grazing ecosystem a relatively constant production of livestock can be expected. In an equilibrium ecosystem livestock density is generally limited by a relatively stable primary production, which - in turn - is controlled by the grazing pressure or livestock density. Hence, an equilibrium between primary production and livestock density will occur (Scoones 1993).

A shift in ecological thinking started in the decades before the paradigm shift. The applicability of Clements' model of vegetation succession for drylands was questioned; primary production of ecosystems receiving less that 400 mm of annual precipitation was suggested being under density independent control in relation to water; and more than one ecological equilibrium was seen as possible in dryland ecosystems (Warren 1995). However, a new model based on these findings was not proposed until the late 1980s. According to this new model, dryland ecosystems are considered disequilibrial, changing from one state to another, due to strong external controls e.g. droughts, fires, or insect attacks (Ellis & Swift 1988). These external controls strongly affect primary production and thus livestock density. In most dryland ecosystems annual grasses constitute an important part of the livestock feed. The natural reproduction of annual grasses occurs from seed banks, where seeds can mature and germinate within 6 weeks in case of sufficient precipitation. Within this limited time the number of livestock necessary to compromise the seed production is very high and usually assumed to be higher than existing livestock population. Annual grasses are also characterised by the fact that biomass is gradually lost by weathering if not eaten (Coppock 1993). Thus, it is difficult to save biomass for the late dry season, and annual means of biomass production makes little sense in relation to the average number of livestock that can survive on this biomass. It should be noted that the vegetation dynamics for annual grasses are different from the dynamics for perennial grasses and trees (browsing), and that the latter also can constitute an important part of the livestock feed, especially late in the dry season. To sum up, the new paradigm is based on the idea that productivity of dryland ecosystems is controlled mainly by the highly variable precipitation: because livestock seldom reaches densities high enough to influence

vegetation productivity, precipitation is the principal factor controlling inter annual vegetation dynamics

There appears to be consensus on the point that the new paradigm is most applicable to arid and semi-arid areas with erratic rainfall (e.g. Ellis et al. 1993, Stafford Smith & Pickup 1993). Arid and semi-arid ecosystems are normally more unpredictable than wet ones, because the coefficient of variation of annual precipitation is inversely related with total precipitation (Ellis 1995). When the coefficient of variation (CV) of annual precipitation exceeds 30%, the long-term performance of ecosystems is better characterised in terms of variability than by measures of mean values (Ellis et al. 1993). Other investigations show that strong feedback between herbivores and vegetation (density dependent regulation) will develop when the CV is below 20% (Ellis 1995).

Pastoral production systems

As far as pastoralism is concerned, the old paradigm consisted of a set of concepts concerning the nature of pastoral societies. Some of the most important ones of these are 'the cattle complex' and 'the tragedy of the commons'.

Herskovits' 'The Cattle Complex in East Africa' from 1926 was one of the first publications on pastoralism to gain international interest. Herskovits claimed that pastoralists' attachment to cattle was so strong that it structured the basic values of their lives (Herskovits 1926). Later, the term cattle complex came to be used within the old paradigm to denote pastoralists' so-called irrational attachment to cattle.

Another important issue of discussion and research within the old paradigm was the idea of the "tragedy of the commons", this concerns over-exploitation of common resources in general. After an article by Hardin in 1968 the concept was very often applied to pastoral production systems. The herder, he claimed, was likely to extend his herd beyond the point of 'overgrazing', because the profit of extra animals went to the herder, while the costs of over-exploitation were held in common by all users and thus, only a fraction was paid by the herder. Hardin concluded therefore that common property would lead to common ruin (Hardin 1968). According to this idea customary tenure systems were assumed destructive, because they gave open access to resources which lead to over-exploitation. Therefore, privatisation appeared to be the solution.

(Coppock 1993).

However, parts of the research community, especially anthropologists, saw pastoral systems as being rational in contrast to the old paradigm (e.g. Gulliver 1955, Barth 1956). Others believed in the rationality of pastoralism and tried to make this fit the ideas of the old paradigm (e.g. Widstrand 1975). Yet some saw pastoralists as being rational from the perspective of their own survival, but regarded them at the same time as backward and causing degradation (e.g. Lamprey 1983).

The droughts in the 1970s and the subsequent development support caused much new development and policy oriented research concerning dryland pastoralism. The focus was often the so-called failure of pastoral production systems; the impact of drought seemed devastating, and development projects seemed to fail (Scoones 1995). Pastoralism was unpopular with most Governments because of the mobile nature of pastoralists which made administration and development work difficult (Hogg 1992). Desertification and degradation became commonplace terms in the discussion of pastoral production systems and pastoralist behaviour was often claimed to be destructive as well as irrational (e.g. Brown 1971, Picardi 1974). The pastoral production systems were accused of causing land degradation, because it appeared that livestock grazing altered the vegetation composition and changed the ability of the land to sustain the livestock and thus the human population (Horowitz 1981). There seemed to be a lack of a coherent theory linking the dynamics of dryland ecosystems to pastoral production systems.

In the 1980s and the early 1990s the picture changed: the idea of nomadic pastoralism as maladaptive was questioned and the environmental problems were seen in a new light (e.g. Sandford 1983, Behnke 1985, Horowitz & Little 1987). Some of the first researchers who drew attention to the need for a complete paradigm shift were Ellis and Swift in 1988. Their background and thus starting point was the functioning of dryland ecosystems: 'African pastoral systems have been studied with the assumptions that these ecosystems are potentially stable (equilibrial) systems which become destabilized by overstocking and overgrazing' (Ellis & Swift 1988, p.450).

With the new understanding of the functioning of dryland ecosystems, pastoral production systems are

analysed in a new light. In highly variable and unpredictable climates pastoral strategies appear well adapted to the environment and not destructive. These strategies include moving herds to make best use of the variable and heterogeneous landscape, various herd compositions and herd splitting practices to make use of the different resources, and economic diversification to support their livelihoods. The lack of ecological equilibrium is no longer regarded a consequence of the pastoral production system, but understood as natural in disequilibrium ecosystems (Sandford 1995).

Another implication of the new paradigm is a rejection of the tragedy of the commons theory. It is realised that most pastoralists do not have open access to all natural resources, but instead different kinds of regulations exist. Moreover, the failure of privatisation projects is acknowledged and customary tenure systems employing access and usufruct rights are being reconsidered (Swift 1995). When the concepts of equilibrium ecosystems and carrying capacity are found inappropriate, the tendency of pastoralists to have large herds is understood as an adaptation to unpredictable ecosystems where a large herd means a bigger chance that some animals survive a drought. Hence, irrationality is reinterpreted as opportunistic management.

Implications for pastoral mobility

Pastoral mobility is often regarded an important characteristic of pastoral production systems in Africa. However, the interpretation of the rationale and importance of pastoral mobility change along with the various discourses, and - just as important - the interpretation varies with the professional background of the researcher. In the following different ideas of pastoral mobility will be discussed. First, ideas and theories based on the old paradigm are mentioned; then, pastoral mobility is discussed in the light of the new paradigm.

Old ideas of pastoral mobility

The ideas and interpretation of dryland pastoral mobility in the past can be divided into two broad categories: one having man (hence, pastoralists) as the point of departure, which is obviously mainly used by anthropologists. They try to understand pastoral systems and in this case mobility as part of the system. Another category has environment (hence, drylands) as the point of departure, and this is mainly advocated by range ecologists. They try to develop optimal utilisation of drylands and can therefore approve or disapprove of pastoral mobility depending on the discourse.

Anthropologists were among the first to acknowledge pastoral mobility as a response to the environment. However, some anthropologists have regarded this explanation nature deterministic: changes in natural resources are not determining for pastoral mobility patterns. Others have claimed it too simplistic: livestock needs are not accepted the primary reason to move. On this background various explanations of pastoral mobility have been developed. One example is 'the military mobility theory' which was developed by Lattimore and Irons (Cribb 1984). According to this mobility is regarded a strategy against encroachment of powerful states. Even though Irons (1968) acknowledges pastoral mobility as 'an ecological requirement', he claims that mobility is determined by military advantage. Pastoral mobility becomes a means of resisting firm government control and of preserving group autonomy against powerful states. It should be noted that Irons' work is based on fieldwork among pastoralists of central Asia in a certain bio-physical and socio-political environment. However, the military mobility theory gained importance as an explanatory model among scholars other than those studying central Asian pastoralists (Cribb 1984).

Let us now turn to the understanding of pastoral mobility among range ecologists. As mentioned, these were mainly occupied with the functioning of drylands and development of sound utilisation of range resources. Thus, pastoral mobility was usually studied within the context of range utilisation. Many of the ideas of range management were developed in the USA and Australia, the main obstacle for a direct transfer of technology and techniques was assumed to be economics.

Le Houérou's 'The Grazing Land Ecosystems of the African Sahel' from 1989 is a typical example of this 'old-paradigm range-ecology' approach. It is worth noticing that Le Houérou's book was published in 1989, the same year as Westoby, Walker and Noy-Meir launched the idea of opportunistic management of disequilibrium rangelands, and a year after Ellis and Swift claimed pastoral practises well adapted to African drylands. According to Le Houérou, pastoral mobility is

inappropriate within the framework of carrying capacity and set stocking rates. Instead rangelands are to be utilised on a permanent basis by ensuring that the stocking rate, and hence grazing pressure, match the long-term carrying capacity. Moreover, livestock should not be allowed to roam freely, instead the range should be divided into paddocks and fenced. This should also prevent 'trespassing of alien herds and flocks' (1989:151) which, according to Le Houérou, is one of the aims of range management.

There are some obvious implications of this approach: stocking rates adjusted to long-term carrying capacity mean that some years have a much higher biomass production than can be eaten by the livestock, given the high variability. However, this is not considered by Le Houérou. Also, the division of rangeland into fenced paddocks is linked to privatisation which means that it hampers pastoral mobility as well as customary tenure arrangements. For Le Houérou this is intentional as customary tenure arrangements are seen as a socio-political constraint for rational range management. Hence, pastoral mobility is sought prevented in various ways.

A new view on pastoral mobility

Anomalies leading to the new understandings of pastoral production systems occurred long before the paradigm shift. Especially anthropologists (e.g. Evans-Pritchard 1940, Stenning 1959, Nicolaisen 1963, Dyson-Hudson 1966) and others studying pastoral production systems (e.g. Gallais 1967, Johnson 1969) have pointed to the flexible strategies employed by pastoralists. With the appreciation of the disequilibrial nature of drylands, however, these findings are placed in a coherent context which is hard to ignore even for policy and development planners. Thus, the new view of range ecologists on drylands is being followed by an awareness of pastoral mobility as a sound response in highly variable and unpredictable climates.

Efficient use of the natural resources requires pastoral mobility patterns at different scales depending on the spatial and temporal variability of the resources and adapted to other elements of the production system. Depending on the degree of variability the pastoral mobility patterns can be more or less regular. In highly variable and unpredictable ecosystems large scale pastoral mobility is a common phenomenon. In these areas cultivation is rare and the population very mobile. In less variable and unpredictable ecosystems, where cultivation is more common (often as agro-pastoralism) and the population more sedentary, variability in resources can often be met by small scale migration to local key resources and harvested fields, or by irregular large scale migrations (Scoones 1995). Key resources or 'wet-lands in dry-lands' are highly productive patches found in low lying areas, along rivers or lakes. Here good grazing can be found when the quality and quantity of the rangeland have declined during the dry season. The production of these areas is likely to vary less between years, and they can thus be used for reducing annual biomass production (Bayer & Waters-Bayer 1995).

Pastoral mobility between different agro-ecological zones means that more livestock can be kept than if the livestock was kept solely in each of the zones. West Africa is an example of how pastoral mobility between different agro-ecological zones can be used for making efficient use of variable natural resources. By using drier areas during the wet season and more humid areas during the dry season, livestock is ensured both high quality and sufficient grazing. However, livestock keeping in the more humid zone is complicated by increased disease risk. This combined with the problem of having livestock near fields in the growing season means that livestock owners in more humid areas are often willing to hire pastoralists to herd their livestock in the drier areas during the cultivation or wet season (de Leeuw et al. 1993). Livestock rearing in the dry zone is mainly constrained by the lack of grazing and sometimes water for the animals. Import of fodder could be one way of overcoming the problem of deficit grazing this being in the dry season or during a drought period. However, this is not economically possible under the present conditions in the Sahel. Hence, pastoral mobility is the most desirable way of exploiting the heterogeneous rangelands (Sandford 1995).

Even though pastoral mobility seems like a sound way of making the most of the variable dryland areas of West Africa, a number of factors are hindering this. In many areas there has been an increasing number of pastoralists turning into agro-pastoralists or more correctly a higher reliance on agricultural production. For agro-pastoralists competition for labour can hamper pastoral mobility, while agricultural activities *per se* can obstruct pastoral mobility through competition over land. The droughts in

the 1970s and 1980s reinforced the agro-pastoral tendency: some lost most or all their livestock and had to rely on agricultural production instead. Many have not had the economic surplus to rebuild their herds, for others migration work in the big cities has taken over as the supplement to agriculture in the risk spreading strategy (Reenberg et al. 1998). Furthermore, settlement schemes, altering of customary tenure regimes, and agricultural encroachment on pastoral areas have hampered pastoral production systems and especially pastoral mobility. In many Sahelian countries the right to land has been linked to the obligation to >mise en valeur= i.e. to ensure a productive use of the land. In many cases pastoral production is not being considered a productive use of the land. This has forced pastoralists to cultivate the areas they use in order to get land rights (Thébaud 1995). It should be kept in mind that even though many pastoralists have become semi-sedentary, mobility is still an important part of the livestock rearing strategy. The distances covered often amount to 20 km per day returning to the camp/village almost every night (e.g. Touré 1990, Milleville 1991, Freudenberger & Freudenberger 1993, own observations from Senegal).

What are the challenges after the acceptance of these new ideas of dryland ecosystems and pastoral production systems? This was addressed at a recent meeting in London on 'Sahel - 25 years after the great drought' (meeting held at The Royal Geographical Society, May 13-14 1998). Flexible responses were mentioned as a solution to unpredictability and variability, pastoral mobility is one such flexible response. Hence, ensuring pastoral mobility was mentioned as an important issue, while, when discussing agriculture, higher production through intensification seemed to be the main issue. However, there was not much discussion of how to integrate these issues, how to ensure unconstrained pastoral mobility while increasing agricultural production. Often conflicts occur where pastoralism and agriculture meet, and it is therefore necessary to make flexible land use and land right arrangements in these areas. Moreover, the areas most suitable for agricultural intensification are often pastoral key resources, for instance river banks or low-lying areas used for late dry season grazing when there is nothing left elsewhere (Scoones 1995). These key resources are vital for pastoral production systems as they have become for agricultural production within recent years.

The Ferlo example

Most of the discussion so far has been fairly theoretical, therefore it seems relevant to turn to an example from the Sahel in order to see how pastoral mobility is used for exploiting variable natural resources. The example is from Ferlo in Senegal.

Ferlo has traditionally been exploited by pastoralists due to low and variable precipitation and lack of permanent water supplies. In the rainy season Ferlo served as a grazing reserve for nomadic pastoralists. Pasture in the area was abundant, but as temporary water holes dried out during the dry season pastoralists moved north to the Senegalese river valley or south and west to the so-called peanut basin (Freudenberger & Freudenberger 1993). In the 1950s the French colonial administration made the first boreholes equipped with motor pumps in Ferlo which meant that the area could be used on a permanent basis. Meanwhile, pastoralism was under pressure both along the Senegalese river valley and in the peanut basin due to agricultural expansion. The opening of Ferlo in the dry season was therefore a needed enlargement of the pastoral area (Sutter 1987). It was followed by new types of pastoral mobility operating at different scales in order to deal with the variability of resources and unforseen events. After the drought years in the 1970s pastoralism in Ferlo was seen as a maladaptive production system causing degradation, tragedy of the commons, etc. This led to a number of development projects in the area. The most interesting of these is the German GTZ project which is one of the few projects in West Africa based on range management techniques from USA and Australia (Thébaud et al. 1995). The project continued for over 10 years and had profound implications for pastoral mobility.

The GTZ project

German activities in the Ferlo started in 1975 with the 'Agro-sylvo-pastoral land use project', an outcome of these activities was the Widou Thiengoli project. Based on the old paradigm mentioned in the previous section the project was set up in the northern Ferlo by the German GTZ in co-operation with the Senegalese government in 1981 (Thébaud et al. 1995). About 14 000 ha of pastoral

rangeland around the borehole of Widou Thiengoli were taken out of the traditional management system. The area was fenced and divided into paddocks with a water supply in each. Set stocking rates were ensured and the paddocks were allocated to families, as a way of giving private land ownership during the project period (Le Houérou 1989). For 12 years environmental impact and socio-economic

At first the interpretation of the results was positive (e.g. Le Houérou 1989), but when the project ended the attitude had changed. The fixed stocking rates meant that the stocking density was too high in bad years and herds had to move out of the project area to survive (Thébaud et al. 1995). In good years unconsumed biomass hampered plant growth in the following years. In fact, stocking rates and available biomass only matched in 2 years. In the project area there was a reduction in drought resistant species but some positive results for ligneous species (Miehe 1991). Based on the results of the project Thébaud et al. (1995) conclude that available herbaceous biomass should be consumed by animals as this favours regrowth, and that trampling can foster establishment of resilient annual species. Concerning livestock performance Thébaud et al. (1995) draw attention to the fact that access to rangeland outside the project area was essential for the herd owners in certain years. In terms of pastoral mobility they note that estimating an ideal stocking density is extremely difficult, and that mobility provides a superior way of utilising variable and unpredictable natural resources. They conclude that 'Herd mobility and flexible land use strategies are ... vital to successful pastoralism' (Thébaud et al. 1995: 20).

Pastoral mobility after the establishment of the boreholes

The migration patterns employed by the pastoralists of Ferlo are an example of how pastoral mobility can be used for tracking variable resources, as advocated by the new paradigm.

Before the establishment of boreholes in the 1950s the area was exploited in the wet season by very mobile pastoralists pursuing large scale migrations. The possibility of staying in the area on a permanent basis meant that people became semi-sedentary settling around the boreholes. Rainfed agriculture was taken up in the area, and more boreholes were established (Touré 1990). For some, the agricultural component of the production system gained importance, especially after the droughts in the 1970s and 1980s.

effects of the project were monitored. Although some changes were made, for instance the area was extended to cover some 20 000 ha, the basic idea of the project was to make a controlled grazing model based on the equilibrium theory concepts (refer to Miehe 1991, Tluczykont et al. 1991, and Thébaud et al. 1995 for a detailed description of the project and the results).

With the increasing pressure on pastoral and agricultural land outside Ferlo, various ethnic groups have moved into the area. Among these is a certain group of Fulani pastoralists coming from the Senegalese river valley. Since the droughts in 1970s and 1980s they have been rebuilding herds of sheep and entered into what could be termed commercial pastoralism. By means of a new labour intensive technology they transport water to the sheep which means that they can make use of the grazing areas far away from boreholes (for further information on this technology, please refer to Juul 1996). This is combined with high mobility and movements around boreholes in a more or less constant radius, in order to find the best pastures for their herd (Juul 1994). Agricultural activities play a minor role, if any, hence households are very mobile. The sheep are mainly raised for sale - the breeding is adjusted to Muslim feasts where there is a high demand for sheep - hence, there is money for buying grain and other necessities. For the commercial pastoralists mobility is a very important part of their strategy. As water can be brought to the sheep, these can constantly be moved to the best pastures without concern for the distance to the borehole (Juul 1995).

However, the majority of the pastoralists in Ferlo have fixed camps and semi-sedentary livestock keeping. Agriculture can be part of the strategy, but it is not always the case (Touré 1990). The labour intensive technology may be used, but usually a variety of animals are kept. The mobility patterns are characterised by daily migration within the borehole area (small scale), but in case of lack of resources migration to other borehole areas (medium) or migration out of Ferlo (large scale) are used. Depending on the year, and thus the amount of grass, part of the household will go on longer migration, sometimes from the middle of the dry season until the start of the next rainy season.

Thus, the pastoral mobility patterns of the Ferlo today can be divided into three categories according to distance: small, medium and large scale migrations. Large scale

migrations are usually practised late in the dry season when grazing resources in the Ferlo are exhausted, or used in years with low or no rainfall at all. Medium scale migrations are used in case of borehole break down, local insect attacks, bush fires, etc. where sufficient grazing can be found in neighbouring borehole areas. Small scale migrations are practised during the rainy season and as long as pasture is abundant.

Touré (1990) employs another way of dividing pastoral mobility in Ferlo: daily migrations, seasonal mobility, and occasional journeys. Daily migrations refer to reasonably regular patterns where the herd moves between the camp, pasture, and water. Depending on the type of animal a herder may be guiding. Small ruminants are herded while cattle are usually left to roam freely. This means that cattle keeping is the least labour intensive. However, leaving cattle without a herder is only possible in safe areas that the cattle know. They are able to find water and pasture and return to the camp at milking time. Daily migration within a borehole area has been termed 'micro-nomadism' (Barrall 1982) and is used by most pastoralists in Ferlo. Daily migration is the same as small scale migration. Seasonal mobility means regular return to the same areas. It can be both medium and large scale. Finally, occasional journeys are unpredictable and can occur in case of bush fire, outbreak of disease, etc. Occasional journeys can be both medium or large scale depending of the event starting them.

To sum up, the opening of Ferlo in the dry season and the semi-sedentary lifestyle of some of the pastoralists have not meant the end of pastoral mobility. On the contrary, natural resources of Ferlo are used through a number of mobility regimes. Mobility is an element of a strategy to balance variability in resources.

Conclusion

The aim of this paper was to consider implications of the new paradigm for one aspect of the pastoral production systems, namely the mobility. It is illustrated how the interpretation of pastoral mobility has changed with different discourses and how it differs between disciplines. It can be concluded that:

Pastoral mobility is highly appropriate in variable and unpredictable environments. An important characteristic of tropical drylands is the heterogeneity of natural resources. Pastoral mobility implies that pastoralists can move to areas with pasture for their livestock. Moreover, pastoral mobility means that the effect of unforeseen events, e.g. outbreak of disease, bush fire, locust attack, can be mitigated. Finally, migration between different agro-ecological zones means that more animals can be kept than the number that can be kept in each of the zones.

Pastoral mobility should be unconstrained for optimal utilisation of variable resources. As pointed out above mobility is a flexible response that allows use of harsh environments. Constraints on pastoral mobility, these being borders, tenure regulations, cultivated areas, etc. hamper the whole pastoral system. Thus, what may appear as a minor constraint in a small area that is not even used very often, may have major implications for utilisation of resources in other areas.

Pastoral mobility is an important element of pastoral strategies. Other elements of pastoral strategies such as herd composition and herd splitting, build upon the possibility of moving the herd. Herd splitting, for instance, does not make sense unless the stock can be moved to different areas.

There are problems ensuring pastoral mobility and agricultural interests at the same time. Within recent years an agricultural expansion into former pastoral areas has taken place, especially pastoral key resources have been taken over by cultivators. With an increasing population it has been necessary to increase agricultural production and pastoral key resource areas are often those areas where the highest agricultural productivity can be obtained. Hence, it is difficult to secure pastoral and agricultural interests at the same time, as this requires flexible land use systems and especially flexible tenure systems.

Several pastoral mobility patterns exist, operating at different scales, overcoming various difficulties. From the Ferlo example it is appreciated that pastoral mobility patterns vary according to the production strategies of the pastoral system. In each case mobility is a basic prerequisite to allow optimal use of variable and unpredictable ecosystems.

Acknowledgements

This appears to be the right occasion to express my

special thanks to Sofus Christiansen for his inspiration and guidance since I started my geography studies. Also thanks to those of my colleagues who have taken the time to read and provide valuable comments to the manuscript.

References

Barrall, H. (1982): Le Ferlo des forages. Dakar, ORSTOM.

Barth, F. (1956): Ecological Relationships of Ethnic Groups in Swat, North Pakistan. American Anthropologist 58: 1079-1089.

Bayer, W. & Waters-Bayer, A. (1995): Forage Alternatives From Range and Field: Pastoral Forage Management and Improvement in the African Drylands. Pp.58-78 in *Scoones, I. (ed.) Living with Uncertainty: New Directions in Pastoral Development in Africa.* Exeter, Intermediate Technology Publications.

de Leeuw, P. N.; Diarra, L. & Hiernaux, P. (1993): An Analysis of the Feed Demand and Supply for Pastoral Livestock: The Gourma Region of Mali. Pp.136-152 in *Behnke, R. H.; Scoones, I. & Kerven, C. (eds.): Range Ecology at Disequilibrium - New Models of Natural Variability and Pastoral Adaptation in African Savannas.* Nottingham, Overseas Development Institute.

Deshmukh, I. (1986): Ecology and Tropical Biology. Palo Alto, Blackwell Scientific Publications.

Dyson-Hudson, N. (1966): Karimojong Politics. Oxford, Clarendon Press.

Ellis, J. (1995): Climate Variability and Complex Ecosystem Dynamics: Implications for Pastoral Development. Pp.37-46 *in Scoones, I. (ed.): Living with Uncertainty: New Directions in Pastoral Development in Africa.* Exeter, Intermediate Technology Publications.

Ellis, J. E. & Swift, D. M. (1988): Stability of African Pastoral Ecosystems: Alternate Paradigms and Implications for Development. *Journal of Range Management* 41: 450-459.

Ellis, J. E.; Cougenour, M. B. & Swift, D. M. (1993): Climate Variability, Ecosystem Stability, and the Implications for Range and Livestock Development. Pp.31-41 in *Behnke, R. H.; Scoones, I. & Kerven, C. (eds.): Range Ecology at Disequilibrium - New Models of Natural Variability and Pastoral Adaptation in African Savannas.* Nottingham, Overseas Development Institute.

Evans-Pritchard, E. E. (1940): The Nuer: A Description of the Modes of Livelihood and Political Institutions of Nilotic people. Oxford University Press.

Behnke, R. H. (1985): Measuring the Benefits of Subsistence Versus Commercial Livestock Production in Africa. *Agricultural Systems* 16: 109-135.

Brown, L. H. (1971): The Biology of Pastoral Man as a Factor in Conservation. *Biological Conservation* 3: 93-100.

Clements, F. (1916): Plant Succession: an Analysis of the development of vegetation. Carnegie Institute, Publications 242.

Coppock, D. Layne (1993): Vegetation and Pastoral Dynamics in the Southern Ethiopian Rangelands: Implications for Theory and Management. Pp.42-61 in *Behnke, R. H.; Scoones, I. & Kerven, C. (eds.): Range Ecology at Disequilibrium - New Models of Natural Variability and Pastoral Adaptation in African Savannas.* Nottingham, Overseas Development Institute.

Cripp, R. (1984): Greener Pastures: Mobility, Migration and the Pastoral Mode of Subsistence. *Production pastorale et société* 14: 11-46.

Freudenberger, M. S. & Freudenberger, K. S. (1993): Pastoralism in Peril: Pressures on Grazing land in Senegal. *IIED Drylands Programme, Pastoral Land Tenure Series No 4.*

Gallais, J. (1967): Le delta intérieur du Niger. Étude de géographie regionale. Tombe I & II. Dakar, Ifan.

Gulliver, P. H. (1955): The Family Herds - a Study of two Pastoral Tribes in East Africa the Jie and Turkana. London, Routledge & Kegan Paul.

Hardin, G. (1968): The Tragedy of the Commons. *Science* 162: 1243-1248.

Herskovits, M. J. (1926): The Cattle Complex in East Africa. *American Anthropologist* 28: 230-272, 361-388, 494-528, 633-644.

Hogg, R. (1992): Should Pastoralism Continue as a Way of Life? *Disasters* 16: 131-137.

Horowitz, M. M. (1981): Research Priorities in Pastoral Studies: An Agenda for the 1980s. Pp.61-88 in *Galaty, J. G.; Aronson, D.; Salzman, P. C. & Chouinard, A. (eds.): The Future of Pastoral Peoples. Proceedings of a conference held in Nairobi, Kenya, 4-8 August 1980.* Ottawa, International Development Research Centre.

Horowitz, M. M. & Little, P. D. (1987): African Pastoralism and Poverty: some Implications for Drought and Famine. Pp.59-82 in *Glantz, M. H. (ed.): Drought and Hunger in Africa.* Cambridge, Cambridge University Press.

Irons, W. (1968): The Turkmen Nomads. *Natural History* 77: 44-51.

Johnson, D. L. (1969): The Nature of Nomadism - a Comparative Study of Pastoral Migration in Southwestern

Asia and Northern Africa. *Research Paper No 118*, Department of Geography, University of Chicago.

Juul, K. (1994): Opportunistiske græsningsstrategier i det nordlige Senegal. *Den Ny Verden* 2, 27: 38-49.

Juul, K. (1995): Agricultural Expansion and Pastoral Production Systems. Pp.99-105 in *Reenberg, A. & Secher Marcussen, H. (eds.): The Sahel: Ethnobotany, Agricultural and Pastoral Strategies, Development Aid Strategies.* Proceedings of the 7th Danish Sahel Workshop. Copenhagen, SEREIN Occasional Paper No 1.

Juul, K. (1996): Post Drought Migration and Technological Innovations among Fulani Herders in Senegal: the Triumph of the Tube! IIED Drylands Programme, Issue Paper No 64.

Lamprey, H. F. (1983): Pastoralism Yesterday and Today: The Over-Grazing Problem. Pp.643-666 *in Bouliere, F. (ed.): Tropical Savannas, Ecosystems of the World*, Vol 13. Amsterdam, Elsevier Scientific Publishing Company.

Le Houérou, H. N. (1989): The Grazing Land Ecosystems of the African Sahel. Springer-Verlag.

Rasmussen, M. S. (1998a): Developing Simple, Operational, Consistent NDVI-Vegetation Models by Applying Environmental and Climatic Information: Part I. Assessment of Net Primary Production. *International Journal of Remote Sensing* 19: 97-117.

Rasmussen, M. S. (1998b): Advances in crop yield assessment in the Sahel using remote sensing data. *Geografisk Tidsskrift, Danish Journal of Geographpy, Special Issue*, 1, 99: 165-170.

Reenberg, A. (1982): Det katastroferamte Sahel - tørke, imperialisme eller andre forklaringer. Geografforlaget, Brenderup.

Reenberg, A. (1987): Satellitbilleder som hjælpemiddel ved praktisk u-landsarbejde i Somalias kystzone. *Geografisk Tidsskrift* 87: 57-64.

Reenberg, A. (1994): Land Use Dynamics in the Sahelian Zone in Eastern Niger - Monitoring Change in Cultivation Strategies in Drought Prone Areas. *Journal of Arid Environment* 27: 179-192.

Reenberg, A.; Nielsen, T. L. & Rasmussen, K. (1998): Field Expansions and Reallocations in a Desert Margin Region - Land Use Pattern Dynamics in a Fluctuating Biophysical and Socio-Economic Environment. *Global Environmental Change* - to appear ultimo 1998.

Sandford, S. (1983): Management of Pastoral Development in the Third World. Bath, John Wiley & Sons.

Sandford, S. (1995): Improving the Efficiency of Opportunism: New Directions for Pastoral Development. Pp.174-182 in *Scoones, I. (ed.) Living with Uncertainty: New Directions in*

Miehe, S. (1991): Inventaire et suivi de la végetation dans les parcelles pastorales à Widou Thiengoli: résultats des recherches effectuées de 1988 à 1990 et évaluation globale provisoire de l'essai de pâturage contrôlé une periode de 10 ans. Unpublished.

Milleville, P. (1991): Les systémes d'élevages. Pp.156-178 *in Claude, J.; Grouzis, M. & Milleville, P. (eds.): Un Espace Sahelien: La Mare d'Oursi Burkina Faso.* Paris, ORSTOM.

Nicolaisen, J. (1963): Ecology and Culture of the Pastoral Tuareg. National Museets Skrifter, Etnografisk Række IX. The National Museum of Copenhagen.

Picardi, A. C. (1974): A Framework for Evaluating Long-Term Strategies for the Development of the Sahel-Sudan Region, Annex 5: A Systems Analysis of Pastoralism in the West African Sahel. Centre for Policy Alternatives, Massachusetts Institute of Technology.

Rasmussen, K. & Reenberg, A. (1992): Satellite Remote Sensing of Land Use in Northern Burkina Faso - the Case of Kolel Village. *Geografisk Tidsskrift* 92: 86-93.

Pastoral Development in Africa. Exeter, Intermediate Technology Publications.

Scoones, I. (1993): Why are there so many Animals? Cattle Population Dynamics in the Communal Areas of Zimbabwe. Pp.62-76 in *Behnke, R. H.; Scoones, I. & Kerven, C. (eds.) Range Ecology at Disequilibrium - New Models of Natural Variability and Pastoral Adaptation in African Savannas.* Nottingham, Overseas Development Institute.

Scoones, I. (1995): New Directions in Pastoral Development in Africa. Pp. 1-36 in *Scoones, I. (ed.): Living with Uncertainty: New Directions in Pastoral Development in Africa.* Exeter, Intermediate Technology Publications.

Stafford Smith, M. & Pickup, G. (1993): Out of Africa, Looking In: Understanding Vegetation Change. Pp. 196-226 in *Behnke, R. H.; Scoones, I. & Kerven, C. (eds.): Range Ecology at Disequilibrium - New Models of Natural Variability and Pastoral Adaptation in African Savannas.* Nottingham, Overseas Development Institute.

Stenning, D. (1959): Savanna Nomads: A Study of Wodaabe Pastoral Fulani of Western Bornu Province, Northern Region, Nigeria. London, Oxford University Press.

Sutter, J. W. (1987): Cattle and Inequality: Herd Size Differences and Pastoral Production among the Fulani of Northeastern Senegal. *Africa* 57: 196-218.

Swift, J. (1995): Dynamic Ecological Systems and the Administration of Pastoral Development. Pp.153-173 in *Scoones, I. (ed.): Living with Uncertainty: New Directions in Pastoral Development in Africa.* Exeter, Intermediate Technology Publications.

Thébaud, B. (1995): Land Tenure, Environmental Degradation and Desertification in Africa: Some Thoughts based on the Sahelian Example. Issue Paper No 57, IIED Drylands Programme.

Thébaud, B.; Grell, H. & Miehe, S. (1995): Recognising the Effectiveness of Traditional Pastoral Practices: Lessons from a Controlled Grazing Experiment in Northern Senegal. Issue Paper No 55, IIED Drylands Programme.

Tluczykont, S.; Richter, M. & Kasberger-Sanftl, G. (1991): Le pâturage côntrolé: un système d'exploitation sylvo-pastorale comme modèlé pour la sauvegarde des ressources naturelles. Saint Louis, Mission Forestiere Allemande.

Touré, O. (1990): Where Herders don't Herd Anymore: Experience from the Ferlo, Northern Senegal. Paper No 22, IIED Dryland Networks Programme.

Warren, A. (1995): Changing Understandings of African Pastoralism and the Nature of Environmental Paradigms. *Transactions of the Institute of British Geographers* 20: 193-203.

Westoby, M.; Walker, B. & Noy-Meir, I. (1989): Opportunistic Management for Rangelands not at Equilibrium. *Journal of Range Management* 42: 266-274.

Widstrand, C. G. (1975): The Rational of Nomad Economy. *Ambio* 4: 146-153.