LAND-USE IN AFRICAN RANGELANDS:

A STUDY OF CHANGE IN BAY REGION, SOMALIA

By

MUJEEB NAHI AL-NAJIM
B.A., M.A.

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Department of Geography and Topographic Science
Faculty of Social Sciences
University of Glasgow

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ABSTRACT

Rangelands in Bay region are used for three main economic activities: livestock grazing, dry-farming and wood collection. Livestock grazing is practised by about 99 per cent of households in the area, and this percentage not only shows that grazing practices are common among the local inhabitants, but that they are controlled by individual households. This implies that herd management techniques (for example, herd size and structure, and livestock movements and sales) are directly related to grazing methods, herd composition and the socio-economic obligations of the pastoral society, rather than to the environmental maintenance of pasturelands. The reason is that pasturelands are communally owned, whilst animals are individually owned. Thus, rangeland resources have come under increasing grazing pressure, owing to the increase in the numbers of livestock, as well as to the changes in herd structure from a reliance on camels and smallstock to a reliance on cattle.

Dry-farming is another form of land-use in Bay region. This land-use activity is common too, as about 93 per cent of the pastoral households are agro-pastoralists. Nevertheless, dry-farming lands occupy only about 11 per cent of the region's land. This is not only due to the amount of rainfall, and its distribution, but also to the distribution of Vertisols, the most fertile soils in the region. However, there has been an increase in the area of dry-farming lands in recent years, although this farming is still largely unaffected by modern farming techniques, and weeds infestation, insect and bird damage and other crop problems are common in the region.

Wood collection is the third land-use type, being in those range areas covered with woody plants. There is no clear division between those rangelands used for grazing and those used for wood collection purposes. This is because range plants provide both a substantial supply of forage for livestock, as well as fuelwood and timber for people. Wood collection for household needs is carried out freely by pastoral groups, most of it being collected from the nearest woodlands, whilst timber for household building and fences is often gathered from woodlots further afield. Charcoal production is another form of wood collection in Bay region. In fact, the region is one of the major suppliers of charcoal to the consumer centre in Mogadishu. There has been an increase in recent years in the amount of charcoal produced and exported from Bay region and surrounding areas to Mogadishu.

A total of 41 selected ecological and socio-economic factors, relating to land-use changes, have been perceived to have changed over the past 20 years in Bay region. It would seem that these land-use changes are more likely to be as a result of increasing human pressures on the rangeland resources in terms of overgrazing, overcultivation and overcutting of woody vegetation, rather than of changing environmental factors such as rainfall. Such pressures have resulted from various factors, such as the communal use of pasturelands and woodlands; the growth of commercial pastoralism; the scale of pastoral development; and the growth of unplanned pastoral settlements. As such, an optimal interplay, between the rangeland potentials and land-use activities, plays a prominent role in the sound management of unreliable range resources.

PART I INTRODUCTION

CHAPTER ONE

INTRODUCTION

1.1 Objectives and Hypotheses

1.1.1 Objectives

The main objectives of this study are to identify recent land-use changes in Somali rangelands, and to offer possible explanations for such changes. There are two broad approaches to achieving these objectives. Firstly, an investigation of the use of Somali rangelands by pastoral groups will be undertaken, by analysing the techniques of grazing, dry-farming and wood collection which are the main forms of land-use in these areas. There is also to be a focus on recent changes in land-use patterns by examining relevant ecological and socio-economic factors, such as range forage availability, herd structure, the management of dry-farming lands and the patterns of pastoral movements. The second approach is to explain the recent changes in land-use types by isolating environmental factors such as climate and soil; technological and economic factors such as veterinary services, livestock sales and farming practices; and socio-political factors such as bride-price and the influence of government policies. In this way, it will become possible to establish the main reasons explaining land-use changes in these areas, and the interrelationships between the various factors.

The study covers a period of 20 years of change, extending from the early 1960s to the early 1980s. This period was chosen, because by around 1960 deterioration in Somali range resources had started to become a matter of great concern (Hemming, 1966; Mahony, 1966; Hartley <u>et al</u>., 1967; Box, 1968). With the exception of some range areas, such as in the northern parts of Somalia, specifically around watering places and where the vegetation had already been cleared, there was much less evidence in the 1950s to indicate that Somali range resources were being seriously exhausted at that time (Hunt, 1951; Klemme, 1957).

1.1.2 Hypotheses

Three main hypotheses focus the study:

(1) In the last two decades the Somali rangelands have been subjected to only partial economic development by the Somali government. This partial development is shown, for example, in the increase of watering points and the improvement in veterinary services, while, at the same time, the availabilty of range forage has not been sufficiently increased nor have pastoral practices been properly controlled or managed. This form of development may therefore have led to an unstable pastoral ecosystem.

(2) Unplanned pastoral settlements, within the currently available range resources, coupled with the communal use of rangelands, create severe environmental problems. In this case, the pastoral practices of grazing, dry-farming and wood collection are concentrated in an unco-ordinated and unplanned way around the settlements. This type of settlement in such arid lands under such land-use conditions, therefore, makes these areas highly susceptible to the destructiveness of drought.

(3) The pastoral people who work in towns, within or outside the study area, have mostly invested their savings in larger herds and more extensive cultivation at home, rather than in improving the productivity of existing production systems. Consequently, additional pressure is being put on the rangeland ecosystems. These stressful conditions will therefore be accelerated, since the pastoral system is such that there are few alternatives to investing this extra income in stock raising and crop production.

1.2 Rangelands in the Third World

Rangelands are those areas which by reason of physical constraints (for example, low and variable rainfall, uneven topography, shallow soil, poor surface drainage and low temperatures) are normally not under forest or permanent cultivation, and are put aside for free-ranging wild and/or domestic animals. These areas cover about 6.7 billion hectares, accounting for about one-half the earth's land surface and occupying regions as diverse as the desert shrub rangelands of North Africa, the Middle East and Central Asia; the tropical savanna rangelands of West, East and south-central Africa and the North American grasslands of the Great Plains (Huss, 1964; Food and Agriculture Organization/ United Nations Environment Programme (FAO/UNEP), 1974; Heady, 1975; Stoddart et al., 1975; Whiteman, 1980). The majority of these rangelands, with more than three-fifths (62.7 per cent) of the total range areas, are found in the Third World. Of these, about 3.2 billion hectares (or more than three-quarters of the Third World's rangelands) are found in the developing countries of Africa and Asia (World Resources Institute et al., 1986).

Rangelands are one of the important environmental resources available in many of these countries, since water, grass and other forage supplies, which are mostly obtained freely from African and Asian rangelands, are fundamental resources for societies which mainly depend upon livestock as a basis of socio-economic life. These societies comprise largely nomadic pastoralists and agro-pastoralists who make a marked contribution to the national economy of their respective countries. In Somalia, for example, the pastoral groups are a principal source of hard currency for the Somali government, since between 70 and 90 per cent of foreign exchange earnings come from the export of livestock (Ministry of National Planning, 1982). Rangelands are also a major source of fuelwood and timber for the local inhabitants. For example, over 80 per cent of the total consumption of the national energy in Mali, Chad, Ethiopia, Niger, Somalia and Sudan is obtained from the woody vegetation of rangelands (Eckholm et al., 1984). To understand the importance of the range resources and their associated problems, it is necessary to understand the socio-economic structure of pastoral societies and their interaction with the environment.

1.2.1 Environmental Resources of African and Asian Rangelands

Rainfall, vegetation and soil are the main environmental resources of African and Asian rangelands. Rainfall is the most important source of water in these rangelands, with other sources such as wells and springs being relatively unimportant. Rainwater is the basis of pastoral systems, not only for drinking, but also for forage, timber, fuelwood and crop production. In Africa and Asia, the rangelands may experience a number of rainfall regimes which are affected by the location of Intertropical Convergence Zone (ITCZ); for example, arid regions with a mean annual rainfall of less than 250 mm and more than 9 months of dry season; semi-arid regions of 250 - 600 mm and 7 to 9 dry months; and subhumid regions of 600 - 1100 mm and about 6 months of dry season (Whyte, 1966). In arid climates, the seasonal water surplus, generally, does not counteract seasonal water deficiency. Consequently, the moisture index is less than zero according to Thornthwaite's (1948) climatic classification. In addition, these regions show the highest degrees of rainfall variability, where the average annual rainfall variability ranges from 20 per cent to over 40 per cent (Trewartha, 1968). In this case, the abnormality in rainfall is a characteristic element of dry climates and, as such, the likelihood of drought is a permanent feature. With the high variability and relative deficiency of rainfall distribution, the productivity of rangelands in terms of range forage, fuelwood and timber owes much to the annual amount of rainfall. The total production of range forage in West African rangelands, for example, is estimated at about 625, 1250 and 1850 kg of dry matter per hectare per year in the arid, semi-arid and subhumid regions respectively (Lamprey, 1983). The seasonal amount of rainfall in these climates, also has a great effect on the productivity of rangelands in terms of rainwater collected for drinking and crop production. In Niger, it has been reported that the yield of millet plus sorghum increases by nearly 200 kg per hectare for each 100 mm increase of rainfall (World Meteorological Organization/United Nations Environmental Programme (WMO/UNEP), 1978). Clearly, rainfall plays an essential role in the biological activity of the rangelands and, as such, its failure can have a devastating effect on rangeland ecosystems.

Vegetation is the second important environmental resource in African and Asian rangelands. Its importance comes from the fact that it is a source of forage for wild and domestic animals, and fuelwood and timber for the human population. This vegetation cover may generally be classified into two main types: desert shrubs and tropical savannas (Keay, 1959; Menaut, 1983; Misra, 1983). Desert shrub rangelands extend in a broad belt from the west of Africa eastward across North Africa and south-west Asia, and through India, China and Mongolia; there is also a zone in south-west Africa from central Angola to the Karoo region of South Africa (Stoddart et al., 1975). These rangelands coincide more or less with a delineation of arid areas with shrubs making up the major part of the vegetation cover, and some herbaceous species in between. These shrubs are woody perennial plants which are mostly dwarf varieties, with heights of less than one metre. Desert shrubs are mainly used as a source of forage for hardy animals like camels, and firewood for local inhabitants.

Tropical savanna vegetation, the second main type in rangeland environments, stretches in a belt from west to east, across north-central Africa, located between the desert shrub rangelands to the north and the tropical forests to the south. Similar savannas occur in south-central and eastern parts of Africa, as well as in India (Stoddart et al., 1975). Tropical savannas are difficult to identify since their vegetation structure can change significantly from one area to another, owing mainly to variations in mean annual rainfall, which can range between approximately 200 mm and 1500 mm annually (Whyte, 1966).

Hopkins (1974), Furley and Newey (1983) and others have therefore classified the tropical savannas into three main types: grass savanna; tree and shrub savanna; and savanna woodland. This classification is based on the density of trees and shrubs in the savanna rangelands, since the grass savanna occurs where trees and shrubs are normally absent; tree and shrub savanna occurs where the woody plants are scattered over a continuous herbaceous layer; and savanna woodland refers to trees and shrubs that generally form a light canopy. The rangelands of West Africa provide an example of these savanna types. These correlate successfully with three rainfall zones: Sahelian (200 - 600 mm), Sudanian (600 - 1100 mm) and Guinean (1100 - 1500 mm) savannas (Lawson, 1966; Whyte, 1966). The vegetation cover of the tropical savannas plays an important part in the economy of the local people since it is a source of timber, firewood, charcoal production, gum arabic and incense. Grazing animals (particularly cattle, sheep, goats and camels) are also kept at large on these savannas.

The soil is the third important environmental resource in African and Asian rangelands. This soil has many types such as Latosols, Vertisols, Regosols, Red and Black soils (Whiteman, 1980). In respect of the fertility of these soil types, Latosols are the poorest, with very little content of organic matter, as in the Indian savannas (Misra, 1983). The richest type is the Black soil with a moderate content of organic matter as in the highlands of East Africa and around Lake Chad (Heady and Heady, 1982). It seems that most soil types of African and Asian rangelands are relatively low in fertility. In this case, they are easily exposed to erosion processes under intensive land-use pressure such as overcultivation.

1.2.2 Socio-economic Structures of Pastoral Societies in Africa and Asia

The social and economic structures of pastoral communities in Africa and Asia are based on a number of values and attitudes. Of these, pastoral ownership, labour, and geographic movements are the dominant socio-economic strategies for ensuring the reproduction of pastoral systems. In respect of pastoral ownership, grazing animals are the basic possession for pastoral groups. For example, the Karamojong tribe of north-east Uganda, and the Dasanetch tribe of south-west Ethiopia often keep cattle, sheep and goats (Dyson-Hudson, 1970; Carr, 1977). Bedouin families of the desert shrub rangelands of Iraq usually own camels and sheep (Thalen, 1979), while the Kel Adrar families of northern Mali have the four species of livestock: camels, cattle, sheep and goats (Swift, 1975). This clearly indicates that several types of livestock are frequently maintained by pastoral groups and this has ecological and economic implications. The fact is that different species make a more efficient use of range vegetation, since camels and goats, for example, are considered to be browsers, although they can be grazers under certain conditions, while cattle and sheep are largely grazers (Heady, 1975). As such, range lands covered with grasses and shrubs are suitable for grazing for all the four main animal species. In addition to the ecological implications, there are economic implications. A combination of different types of livestock means that the pastoral groups have different production systems in terms of milk, meat, skins, fat and blood (Dahl and Hjort, 1976). In this case, species' diversification is an important strategy for household security in terms of ensuring minimum subsistence if one of these species is affected by disease or lack of drinking water or forage. In fact, pastoral groups do not only maintain different types of livestock, but they also tend to maximise the number of animals kept. This results from two different systems dealing with the ownership of grazing animals and the use of rangelands, since the former is individually owned while the latter is communally used (Allan, 1965; Swift, 1982; Stryker, 1984). Thus, the communal system as a form of land-use is tragic as rangelands become overstocked (Hardin, 1968). Nevertheless, the maintenance of larger numbers of livestock does not only give greater subsistence levels and higher social standing, but also provides relative security for the pastoral household. This is so, as larger herds give a greater chance that at least some might survive for subsistence needs and rebuilding of the herds, even after large-scale animal loss (Allan, 1965; Dahl, 1981). There is also higher security in the sense that the larger population of livestock, the smaller the probability of all the cows drying up at the same time (Dahl and Hjort, 1976; Dahl, 1981).

Pastoral labour is another important element of pastoral societies in Africa and Asia. Labour in these societies, is supplied by the families and, as such, both sexes are involved. For example, both male and female labour of the Karamojong pastoralists of north-east Uganda, and the Dasanetch pastoralists of the south- west Ethiopia is included in the production processes of the household. These processes include grazing and milking of animals, seeding and harvesting of crops, fishing and hunting, gathering of wild fruits, roots and stems, and bartering and selling of goods (Dyson-Hudson, 1970; Carr, 1977). The fact is that these are productive activities, but not production _per se_ (Carr, 1977). In this case, pastoral labour is ineffectively used since poorly-managed rangeland ecosystems can lead, for example, to the loss of animals owing to drought, and the failure of crops because of lack of rain. In addition to immediate family labour, the pastoral household also relies on labour from the closest relatives and in-laws (Dahl, 1981). It is reasonable to rely on people with whom one has bonds of reciprocal solidarity for herding practices, since the livestock owner can exercise a strong degree of social control on those relatives and in-laws who carry out the pastoral work, and hence avoid misappropriations of livestock or animal theft which might take place if herders, who are not relatives and on whom a strong control cannot be excersised, are employed.

Pastoral movements comprise the third structural element of pastoral groups in Africa and Asia. These movements which involve both people and their animals, are bound up with the need to make the most effective use of range resources, especially range forage and drinking water, and to avoid low temperatures at the highlands in the winter as well as biting flies. Pastoral movements are also affected by socio-economic factors, such as available labour supply, the location of market and service centres and ownership of farming lands (Davies, 1966; Johnson, 1969; Gulliver, 1975). For example, the Rufaa' el Hoi tribe of the Gezira area, between the Blue and White Niles of Sudan, usually grazes its camels, sheep and goats in the drier areas, in the immediate vicinity of Managil, for as long as the rainy season continues, while cattle are grazed further south. In the dry season, Rufaa' el Hoi nomads and their livestock migrate back to the grazing areas of southern Gezira. As such, the Rufaa' el Hoi manage to make effective use of the available range forage and drinking water in the northern and southern rangelands of the Gezira area. In addition, they effectively avoid the biting flies in the southern grazing areas, since these flies are more active during the rainy season (Davies, 1966). The Bhotia pastoralists of India show another pattern of pastoral movements. These pastoralists and their animals migrate down to the low pastures of the warmer valleys of the Himalayas in the winter where they trade in wool accumulated in the summer. In the summer, they migrate up to the high pastures along the Tibetan frontier; women and children remain there grazing their animals, while the Bhotia men continue on to Tibetan markets to trade Indian goods for wool (Palmieri, 1982). Consequently, the Bhotia pastoralists make full use of range resources. It seems that the distance moved, routes followed and the degree of flexibility built into the system vary from year to year, place to place or herd to herd, and even from one pastoral group to another (Johnson, 1969; Oba and Lusigi, 1987). Nevertheless, pastoral movements remain one of the most important pastoral stategies for the security of livestock from loss owing, for example, to the lack of drinking water and range forage. These movements are also an important strategy for managing rangelands. The mobility of stock involves an intermittent use of range resources, especially range forage (Oba and Lusigi, 1987), and therefore can be interpreted as a way of managing range resources without overusing them and causing degradation. As such, pastoral movements are the most approprate form of land-use of African and Asian rangelands since these rangelands are communally exploited and can be extremely fragile.

1.2.3 Environmental Problems in African and Asian Rangelands

There are a number of important environmental problems to be found in most African and Asian rangelands. Excessive exploitation is one of the most pressing problems, and this is due to varying degrees of overstocking, overcultivation, grass-burning induced by Man, and overcutting of woody vegetation. Overstocking refers to a stocking rate that exceeds the carrying capacity of range area, and the term of carrying capacity is concerned with the maximum numbers of livestock that can graze on a given area of range throughout a complete year without inducing deterioration of the range resources (Huss, 1964; Heady, 1975; Stoddart et al., 1975; Strange, 1980a). In this case, continued overstocking would, of course, induce overgrazing which refers to the excessive defoliation of plants through animal feeding and excessive damage to plants through animal trampling. A number of studies and reports have discussed the problem of overgrazing over many areas of African and Asian rangelands (Pearse, 1970; Grove, 1973; FAO/UNEP, 1974; Rapp, 1974; Le Houerou, 1975; Swift, 1975; Le Houerou, 1976; Babayev, 1977; Le Houerou, 1977; Ware, 1977; Warren and Maizels, 1977; Thalen, 1979; Lamprey 1983; World Resources Institute et al., 1986 and Biswas et al., 1987). However, many lack thorough explanations of the processes of degradation since there is generally a lack of reliable data on both numbers of livestock and carrying capacities of rangelands in most of the relevant countries. For example, the steppe pasturelands of North Africa (Morocco, Algeria, Tunisia, Libya and Egypt) are characterized by widespread overgrazing, with an average rate of stocking of one sheep per two hectares, while the carrying capacity of these pasturelands is put at one sheep per four hectares on average (Le Houerou, 1975). In Zambia, the numbers of livestock have also been 10 - 15 times higher than the calculated carrying capacity of Zambian rangelands (World Resources Institute et al., 1986). In Niger, the grazing pressure has surpassed the carrying capacity of Niger's rangelands, although no quantitative data are given (Perrier, 1986).

Excessive defoliation of plants caused by animal- feeding is explained by Heady (1975), Stoddart et al. (1975), Whiteman (1980) and others, as occuring when a greater percentage (normally more than 50 per cent) of the total primary production of foliage of the most palatable species (usually grasses and herbs) have been consumed by the larger grazing herds. These plants then fail to form seed or to transfer nutrients to their root storage area during the growing season. These species are therefore unable to reproduce themselves as they become less frequent in plant communities. As these plants become increasingly rare in the pastureland, livestock turn to woody shrubs which are less palatable compared to the herbaceous species. Consequently, the process of overgrazing continues, the woody shrubs will in their turn become rare too. All these species, which gradually disappear from pasture, are called "decreasers" (Dyksterhuis, 1949). In the Kordofan region of Sudan, for example, the palatable species such as Aristida plumosa; Belpharis and Monsonia spp. have completely disappeared over a wide area of the eastern part of the region due to increased grazing pressures, as the numbers of livestock have multiplied by more than four times during the 24-year period from 1957 - 1981 (El Sammani and Abdel Nour, 1986). In the desert shrub rangelands of Iraq, it has also been reported that some palatable species such as Artemisia herba-alba, are often heavily grazed (Thalen, 1979). The space, moisture and nutrients used by those palatable and less palatable species are then colonized by the remaining plants which are mostly weeds or weed-like species. There is therefore a greater opportunity for the unpalatable species to expand their cover over a wider area of rangelands and as such they are called "increasers" (Dyksterhuis, 1949).

In addition to the defoliation of plants, there is the trampling of animal hooves which put the ground cover, especially the most sensitive species like grasses, under greater pressure as the numbers of livestock expand. Consequently, the most sensitive plants become less dense, while the hardier species, mostly weeds, become denser. If the accumulation of livestock continues in the African and Asian rangelands, the devastation of vegetation cover, including the hardier species, is, therefore, likely to be as much a result of animal trampling as of feeding habits. Such severe trampling action also damages soil surfaces by pounding, powdering or puddling the fine materials which are then easily carried away by wind and water (Warren and Maizels, 1977).

Overcultivation is another dimension of the excessive use of African and Asian rangelands. This problem results from the change from shifting or fallow systems of agriculture to more permanent systems of cultivation, and from the expansion of croplands from the wetter areas to the drier areas as in the arid lands (Pearse, 1970; Le Houerou, 1976; Strange, 1980c; Bebawi et al., 1985; D'Souza and Shoham, 1985; Gibbon and Pain, 1985; Grainger, 1986). These situations have put the cultivated areas under greater pressure because of low and erratic rainfall, which does not easily allow the practice of continuous cultivation in the drier areas. The decline in soil fertility is the clearest indicator of excessive cultivation pressure, resulting in a marked reduction in crop productivity. For example, in Kordofan region in Sudan, about 5 hectares were needed in 1972/1973 to produce the same yield of groundnuts as produced from one hectare in 1960/1961 (Le Houerou, 1977; Grainger, 1986). The excessive cultivation pressure also results in the destruction of range forage species which are then often replaced either by annual weeds, having little nutritive value, or by unpalatable species, such as Peganum harmala in the temperate rangelands and Calotropis procera in the tropical rangelands (Le Houerou, 1977).

Grass-burning induced by Man is the third aspect of the excessive utilization of African and Asian rangelands. Fire is usually set in the savanna rangelands in order to get rid of coarse dry grasses, and to stimulate the underground parts of the plant to produce new green shoots for animal grazing (Lawson, 1966). As such, most burning is undertaken in the grasslands of perennial species, as in the Sudanian savanna, while the grasslands of annual species are less prone to such burning (Gillon, 1983). The perennial grassland species have underground stems or root stocks that carry buds whose growth is actually stimulated after burning, since fire leads to the removal of the above ground part of the grass which is already old and dry (Heady and Heady, 1982; Tivy and O'Hare, 1985). In this case, the burning of the perennial species has a positive effect on their regrowth, in contrast to the burning of the annual grasses which can cause a delay in the regrowth of grass plants, owing to the destruction of their seed crops by the heat. The burning of perennial grassland species is therefore necessary to regulate the productivity of range forage by destoying dead and decaying grasses, and allowing new fresh grasses to spring up. Nevertheless, the burning has a marked effect on rangeland ecosystems. For example, the risk of soil erosion increases on burnt grasslands, with about 150 kgs per hectare per year being estimated to be lost by erosion processes after burning, as against only 50 kgs per hectare per year in unburnt grasslands (Gillon, 1983).

Overcutting of woody vegetation is the fourth aspect of the excessive exploitation of African and Asian rangelands, since woody plants are the principal, if not the only, source of fuel and building materials for pastoral communities and those who live in the neighbouring towns (Pearse, 1970; Grove, 1973; Le Houerou, 1977; Strange, 1980c; Eckholm et al., 1984; Grainger, 1986). Overcutting refers to an excessive exploitation of wood resources resulting in a marked reduction in woody species in the rangelands. For example, most firewood plants, like Haloxylon ammodendron, have almost disappeared from the desert shrub rangelands of Iraq owing to excessive cutting for fuel (Thalen, 1979). Overcutting does not only lead to a reduction in the potential woody plants, but also helps to accelerate soil erosion, since soil surfaces are left without any or with only poor vegetation cover.

Although, these four types of overexploitation of African and Asian rangelands have been treated separately in this discussion, in reality three of these practices, animal grazing, grass-burning and woodcutting, are frequently carried out in the same range area. In this case, a widespread deterioration of rangeland ecosystems caused by Man's activities, has taken place over most African and Asian rangelands, largely as a result of the combination of these effects.

Drought is the second critical environmental problem of the arid, semi-arid and subhumid rangelands of Africa and Asia. This problem can be traced back more than 3500 years, when Egypt and most parts of the Middle East experienced severe drought conditions and famine during Joseph's period (American Bible Society, 1976). Drought, clearly, has a long history in these rangeland areas, and is still, directly or indirectly, the major cause of famine. Again, drought can be seen as part of the normal climate of the arid lands. The trend, however, seems to have changed since 1968, and drought has become more persistent due to the trend of declining rainfall (though with some fluctuations) over most African and Asian rangelands (Nicholson, 1983; WMO, 1983; Todorov, 1985). Other studies indicate that the present prolonged drought began further back in 1961 (Gregory, 1983) or in 1956-1957 (Winstanley, 1973a; Krishnan, 1977; Chowdhury and Hussain, 1981; Hare, 1983). However, this situation is not well understood. Drought is not unusual in these regions, but for it to continue over so many years, as has happened in north-east Africa (Trilsbach and Hulme, 1984), is unusual and suggests a changing relationship between direct climatic changes, indirect climatic changes and normal climatic fluctuations.

Climatic change is a topic which is both complex and controversial, but it seems that prolonged droughts can be related to direct changes in the atmospheric circulation. For example, Lamb (1966) and Winstanley (1973a, 1973b) showed that since the 1950s, the meridional circulation in the tropics has contracted due to the expansion of cold air from the polar zones. This change has pushed the subtropical climate nearer to the Equator, leading to reduced amounts of monsoon rainfall (for example, in the Sahel and the north-western region of India), while higher amounts of winter-spring rainfall have occured in the Mediterranean and the Middle East. Such changes in the general circulation of the atmosphere might have a significant influence on the climate of much of the world, but its effect seems to be just local since there is, for example, no indication of such climatic shift at the poles. In fact, subtropical climate as over the North Atlantic has rather moved slightly polewards (Miles and Follard, 1974). On the other hand, Winstanley (1973b) has declared that this protracted drought is going to last for almost 50 years. This would seem to be of a shorter time-scale compared with other trends of climatic changes, such as the minor changes which can last for a few hundred years (Whyte, 1963). Nevertheless, this shorter period may have a considerable influence on the rangeland ecosystems since these systems have actually collapsed in some range areas, such as in northern Ethiopia, even though only about two-thirds of the 50 year period have so far passed.

The interaction between the El Nino phenomenon (an anomalous warming of the upper part of the eastern equatorial Pacific off the coasts of Peru and Ecuador) and the southern oscillation (the seesawing of mean pressure differences at sea level, between the western and eastern equatorial Pacific) is another direct change in the climate associated with droughts and other anomalies of climate around the world. This oceanic-atmospheric variability is called the El Nino - Southern Oscillation (ENSO) event (Rasmusson and

Wallace, 1983). The typical area of the ENSO event is the Pacific and Indian Oceans. Rasmusson (1987a, 1987b) has found some strong relationships between the ENSO events and rainfall failure in those areas, especially in the sub-continent of India, and south-eastern Africa (Mozambique - Zimbabwe southward through Botswana and northern South Africa). In the latter region, he illustrated that 22 of the 28 ENSO events during the last 110-year period of 1875 - 1985 coincided with sub-normal rainfall conditions. As yet, no strong correlations have emerged between the ENSO events and drought conditions in East Africa or in the Horn of Africa. However, it should be emphasised that these and many other relationships between climatic variables do not necessarily have strong correlations, even if they occur in the same period of time. For example, sea surface temperature (SST) variations in the tropical south Atlantic do not appear to be related to the ENSO events in the Pacific-Indian Ocean area. Thus, there is no clear correlation between the Sahelian droughts of West Africa and the ENSO events, but there is some relationship between these droughts and the warmer than normal waters in the tropical south Atlantic, especially in the Gulf of Guinea (Glantz, 1987a; Rasmusson, 1987a).

The present prolonged drought has also been related to indirect changes in the atmospheric processes that control climate, resulting from increased Man's activities such as the clearance of vegetation and the combustion of fossil fuels. These activities have led to an increase in the content of carbon dioxide and dust in the atmosphere which might upset the natural system of climate. The content of atmospheric carbon dioxide changed from 280 - 300 parts per million (ppm) in 1880 to 335 - 340 in 1980, due mainly to the increased consumption of fossil fuels and the burning of forests (Wong, 1978; Hansen et al., 1981). The increase in the levels of atmospheric carbon dioxide has contributed to an increase in the global temperature, since carbon dioxide has an important role in modifying the vertical distribution of temperature in the atmosphere by controlling the flux of infrared radiation through the "greenhouse effect". It has been estimated that the global mean surface temperature will rise by about 0.01^{0} C per one ppm carbon dioxide increase (Bryson, 1974). Consequently the atmospheric temperature rose between 0.4^{0} - 0.6^{0} C during the 100-year period 1880-1980. Such a slow warming of the lower atmosphere might have an effect on hydrologic processes and the location of rainfall regimes, although the regional effects are not yet well understood. Notwithstanding, some scientists like Bryson (1973) have speculated that the recent drought conditions in the Sahel, for instance, may be the first manifestation of the regional effect of such a warming (Glantz, 1987a).

The increasing level of atmospheric dust is another indication of indirect changes in the climate. Apart from natural processes (for example volcanic eruptions), this increase has also been affected by the encroachment of Man's activities in rainfed cultivation, animal grazing, and wood cutting. Bryson (1974) estimated that about 100 to 250 million metric tons of dust are annually deposited into the lower atmosphere from the deflation of soil disturbed by agriculture and construction alone. Dust can easily be generated from bare and sparsely vegetated surfaces, already exposed by overgrazing, overcultivation and overcutting. For example, the intensive agricultural exploitation of the desert margins of north-west India create a dense pall of local dust in the atmosphere, since larger areas of surface materials are exposed to deflation in dust storms (Bryson and Baerreis, 1967). The blowing of white sands in the Sahel is another indication of overused soils which were previously protected from wind erosion by vegetation or accumulated organic matter in the soil, and which eventually lost their protection and became lost (MacLeod, 1976). However, Man-made increases in atmospheric dust concentrations might have some effect on the rainfall levels, since dust cools the surface of the earth by absorbing and scattering some of the solar radiation. MacLeod (1976) illustrated that the increased amount of dust in the lower atmosphere of the Sahelian zone has suppressed the formation of cumulus (rain) clouds along the ITCZ. Consequently, rainfall along this front is reduced, producing a drought. This hypothesis can be applied elsewhere in the African and Asian rangelands since rainfall regimes over these areas are widely affected by the location of ITCZ. Thus, increased animal grazing, woodcutting and rainfed cultivation over these range areas can annually introduce a substantial amount of dust into the lower atmosphere which could, in turn, increase the frequency of drought by its persistent effect on rainfall levels.

In fact, 20 or so consecutive drought years probably constitutes a long enough period of time to create sparse vegetation cover (Menaut, 1983), causing fine surface materials to be easily blown away and therefore affecting and reducing the frequency of showers. Moreover, the depletion of vegetation cover itself reinforces drought occurrences on a regional scale, since the ratio of the amount of electromagnetic radiation reflected from ground surfaces without vegetation cover is higher than those surfaces covered by vegetation. This mechanism is called albedo and is commonly expressed as a percentage. It has been estimated that ground covered by plants may have an albedo as low as 30 per cent, while the albedo of bare ground may be as high as 45 per cent (Budyko, 1974). The impact of vegetative changes on albedo in the Sahel has been argued by Charney and his colleagues (1975a, 1975b). They suggest that an increase in ground-surface albedo, resulting from a reduction in plant cover, would contribute to a decrease in the net incoming radiation and an increase in the radiative cooling of the air. This would cause the air to sink to maintain thermal equilibrium by adiabatic compression. Cumulus convection, and its associated rainfall, would be suppressed and, at this stage, a positive feedback mechanism would appear because the lower rainfall would in turn have an adverse effect on vegetation cover by increasing its depletion condition. This situation would initiate a constant drought, since further reductions in plant cover would produce an increase in surface albedo of the earth. This hypothesis answers the question: does drought feed on drought? The fact is that drought itself reduces vegetation cover and creates a condition for its own continuation. Nevertheless, this hypothesis has been challenged by Ripley (1976), who suggested that Charney and his colleagues, while considering the impact of vegetation changes on albedo, have completely ignored the effect of vegetation on evapotranspiration. He pointed out that vegetated surfaces are usually cooler than bare ground because much of the absorbed solar energy is used to evaporate water. He concluded from this that protection from overgrazing, for example, might be expected to lower surface temperatures and thereby reduce, rather than increase, convection and precipitation.

The third standpoint considers the present lengthy drought in north-east Africa as just part of the normal fluctuations in the climatic system of dry regions. Drought in these regions can occupy up to a decade or more, as well as shorter periods of one to three years (Goudie, 1972; Grove, 1973; Hare, 1977; Kovda, 1980; Rasmusson, 1987a). For example, in the Sahelian - Sudanian zones, rainfall observations show some long-term drought episodes of about 10 years during the 1910s, as well as short-term durations (Nicholson, 1983). In north-west India, rainfall records also show some long-term drought periods of 10 years and more, as from 1895 to 1915, that were certainly as long as the present drought, in addition to the short-term drought periods (Krishnan, 1977). In this case, the present drought is not unique, and the drought phenomenon should then be viewed as an expected problem in the dry regions, but not necessarily to be regarded as a regular characteristic. The present trend of lower than average rainfall over most African and Asian rangelands can therefore be explained as a combination of long-term drought episodes and some climatic modifications which cannot be ignored. This results in the present extraordinary conditions of drought and of its intensity and extent. As such, this drought has not only caused starvation for the affected people (Timberlake, 1985), but it has also contributed to an acute breakdown of society as these people had to evacuate the drought areas. In Mauritania, for example, the recent drought conditions have led to a marked reduction in the percentage of pastoral groups from 83 per cent to only 25 per cent of the total population between 1963 and 1980, while the percentage of town dwellers, especially in the larger towns like Nouakchott, have increased from 17 per cent to about 75 per cent of the total population of Mauritania during that time (Hilling, 1987).

Desertification is the third environmental problem, since most African and Asian rangelands are generally under the threat of severe processes of desertification (Dregne, 1977, 1984; Mabbutt, 1984). Desertification was in the 1960s defined by Le Houerou as:

> "The extension of typical desert landscapes and landforms to areas where they did not occur in the recent past." (Le Houerou, 1977: 17).

This process accordingly takes place most commonly in the arid zones with an average annual rainfall of 100 to 200 mm, with the highest amount being up to 300 mm. Obviously, Le Houerou's definition does not include desertification processes in the neighbouring regions of higher annual rainfall amounts, such as the semi-arid lands (Glantz, 1977). Rapp (1974) therefore extended Le Houerou's definition to include areas of higher annual rainfall up to 600 mm, as follows:

> "Desertification: the spread of desert-like conditions in arid or semi arid areas, due to man's influence or to climatic change." (Rapp, 1974: 3)

The definition of desertification used by the United Nations (1977) bears some resemblance to Rapp's definition, but emphasises the diminution or destruction of the biological potential of the rangelands, which can lead ultimately to desert-like conditions. In this case, desertification is an aspect of the widespread destablization of rangeland ecosystems, by which the biological productivity of the land is reduced to low levels. The reduction in biological productivity of African and Asian rangelands is mostly seen through the impoverishment of plant growth and the exposure of soil surfaces to accelarated erosion. These processes result from increasing drought conditions and/or from excessive pressure due to Man's use of rangeland ecosystems.

The connection between drought and desertification has been addressed by many authors. For example, the United Nations (1977) noted that drought can advance the process of desertification, while Grainger (1986) mentioned that drought can trigger rapid desertification. This nexus has clearly been explained by Glantz who indicated that:

> "Drought can in many instances accelerate, and in some cases initiate, desertification processes, though desertification also occurs in the absence of drought." (Glantz, 1987b: 24).

However, drought often leads to a decrease in vegetation cover, by reducing its growth rate, and consequently soils are left with poor plant cover, which does not provide sufficient protection to prevent erosion processes. When soil is dry and not well protected, wind can easily blow away loose particles of topsoil and bounce them along loosening more soil. Dry and unprotected soil can also be eroded by splashing raindrops which loosen soil particles, when rainfall resumes. These results signal the beginning of desertification, since the biological productivity of land declines. As drought continues, the loss of biological productivity of land increases and consequently prolonged drought, like the present one, becomes an active contributor to desertification processes due to the permanent loss of biological productivity. Thus, desertification is accelerated during times of protracted drought while it is slowed during more favourable periods (Dregne, 1977). This implies that many years would be required to rebuild soil and vegetation resources, and hence re-establish the favourable microclimate that had been lost (Hare, 1983).

Desertification is also a function of land-use systems typified by overgrazing, overcultivation, grass-burning and overcutting - especially around watering points and settlements. Overgrazing, grass-burning and overcutting denude the rangelands of their plant cover, and consequently soils are greatly prone to wind and water erosion. As the soils are left without shelter and are disturbed by animal trampling, fine material may easily be washed away by flowing rainwater, or blown away by wind in dust-storms. Overcultivation deprives the soil of the organic matter which is essential for binding the soil particles together. As such, the soils are exposed to wind erosion during the dry season and water erosion during the rainy season. These processes involve a shift from productive rangelands to more desert-like conditions owing to Man's mismanagement of rangeland ecosystems. Clearly, it is difficult to distinguish between the contribution of the direct effects of drought and the excessive exploitation and harmful consequences of human pressure on rangeland resources (Grove, 1973). However, desert encroachment has been reported in most African and Asian rangelands. For example, in Sudan, the southern limit of the desert has advanced southward by about 100 km over the past 17 years at a rate of about 6 km per year (Ruddle and Manshard, 1981). In West Africa, the southern limit of the Sahara has also moved southward by about 150 km in general (Tolba, 1986), and, in particular, by about 350 km in Central Gourma in east Mali (World Resources Institute et al., 1986).

The fourth environmental problem of African and Asian rangelands are those which are brought on by plagues of locusts. The destruction caused by these pests can be extreme, because they are capable of completely defoliating vegetation cover and consuming all greenery in their way. The threat of locusts in many areas of African and Asian rangelands, has resumed again for the first time in thirty years (MacKenzie, 1988). Some serious locust plagues have been reported in the second half of 1970s in a number of areas, as in the Horn of Africa and the Arabian peninsula (Salwi, 1978; Sherwell, 1978). However, it was reported in the last quarter of 1986 that numerous swarms were making their way from the coastal areas of the Red Sea towards Saudi Arabia, Ethiopia and Sudan, reaching the south-eastern part of Egypt. In addition, small swarms have been reported in Morocco, Tunisia, Somalia, Yemen, Kuwait, Pakistan and India (Food and Agriculture Organization (FAO), 1986).

The present threat of locusts is due to unusally heavy rains and ineffective spraying methods. The 1985 rains, for example, which temporarily ended the widespread drought in most of the relevant countries, provided ideal breeding conditions for locusts (Overseas Development Administration (ODA), 1987). The current restriction on the use of Dieldrin insecticide is another factor to consider in the present threat of locusts. This insecticide has a long-term effect on the locust breeding grounds. but its use ceased in early 1980s, because of its effects on other land ecosystems, such as the production of crops (MacKenzie, 1988). Fenitrothion insecticide, which does not have such a destructive effect on the land ecosystems compared to Deildrin, has since been used instead. This has a shorter-term effect on the breeding conditions of locusts, as three sprayings of Fenitrothion are necessary to kill off a swarm of locusts which, in comparison, was previously treated with only one spray of Dieldrin (Matheson, 1987). In this case, Fenitrothion has to be used intensively, or the problem of locusts remains as a potential threat to plants, especially during the rainy periods.

Many species of locusts, such as Desert and Brown locusts, have been identified in African and Asian rangelands in addition to grasshoppers. The Desert locust <u>Schistocerca gregaria</u> is the most serious problem, since its distribution covers a wide belt of about 30 million square kilometres. This belt stretches from the Atlantic coast of Africa to Bangladesh and from Turkmenia in the southern Soviet Union to Tanzania (Waloff, 1966). Nevertheless, the annual frequency of the Desert locust infestations is different from one area to another. During the 25-year period from 1939 - 1963, the annual infestations of Desert locust swarms ranged from 4 per cent in Turkmenia to 95 per cent in Sudan, Ethiopia, Aden and Pakistan (The Anti-locust Research Centre, 1966). The other locust species are mostly found in scattered areas of the Sahel, East Africa and southern Africa. They are therefore not such a threat to the vegetation cover of rangelands (ODA, 1987).

1.3 <u>Rangelands in Somalia</u>

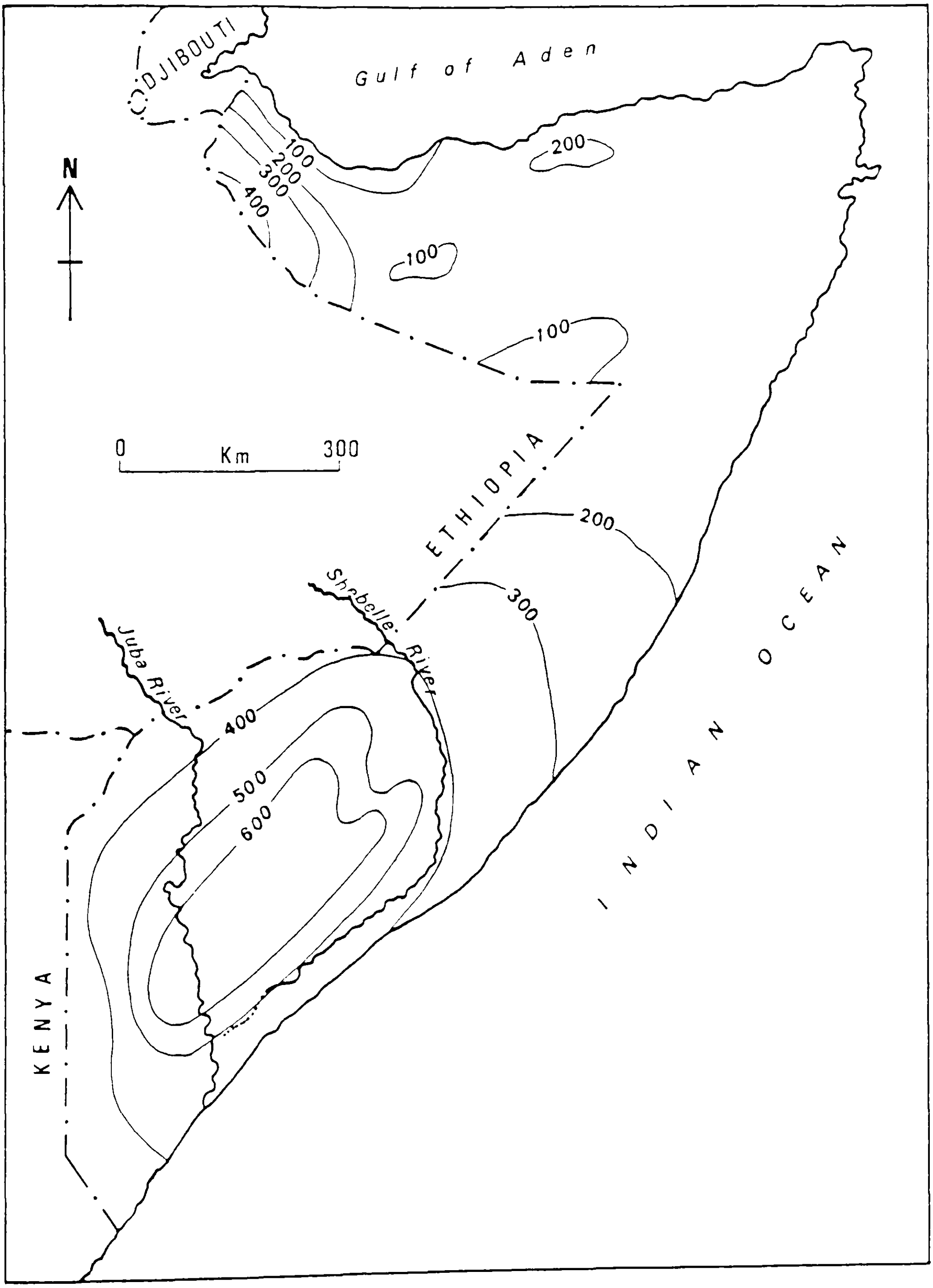
Rangelands are one of the most important national resources in Somalia. It is generally estimated that about 80 per cent of the land area of Somalia is covered by rangelands which are the main source of livelihood for more than 66 per cent of the Somali population (Ministry of National Planning, 1982; Central Statistical Department (CSD), 1984). These rangelands have been discussed in a range of studies dealing with the environmental resources of rangelands, the socio-economic structures of pastoral groups and the environmental problems of these areas. It is also notable that these studies have been mostly concerned with the inter-riverine rangelands in the southern parts of Somalia.

1.3.1 Environmental Resources of Somali Rangelands

Rainfall is arguably the most critical environmental resource in the Somali rangelands. The average annual isohyets over Somalia show two main rainfall regimes: arid and semi-arid climates (Meigs, 1953; Griffiths and Hemming, 1963; Griffiths, 1972). As shown in Figure 1.1, the arid climate, with a mean annual rainfall of less than 200 mm, is found in the north-eastern and central areas of Somalia. The semi-arid climate with a mean annual rainfall of 200 to 600 mm occurs in the north-western and the southern areas of the country. These regimes, however are generally erratic in time, amount and local distribution, since they result from local convectional storms that give a small number of heavy showers (Grigg, 1970). In this case, the seasonal and annual productivity of rangelands varies considerably from one rainy season to another and from one year to the next.

Vegetation is the second important environmental resource in Somali rangelands. It has been studied, in brief, for all of Somalia by Glover (1947), Pichi-Sermolli (1955), and Hartley <u>et al.</u> (1967), and in some detail for specific range areas,

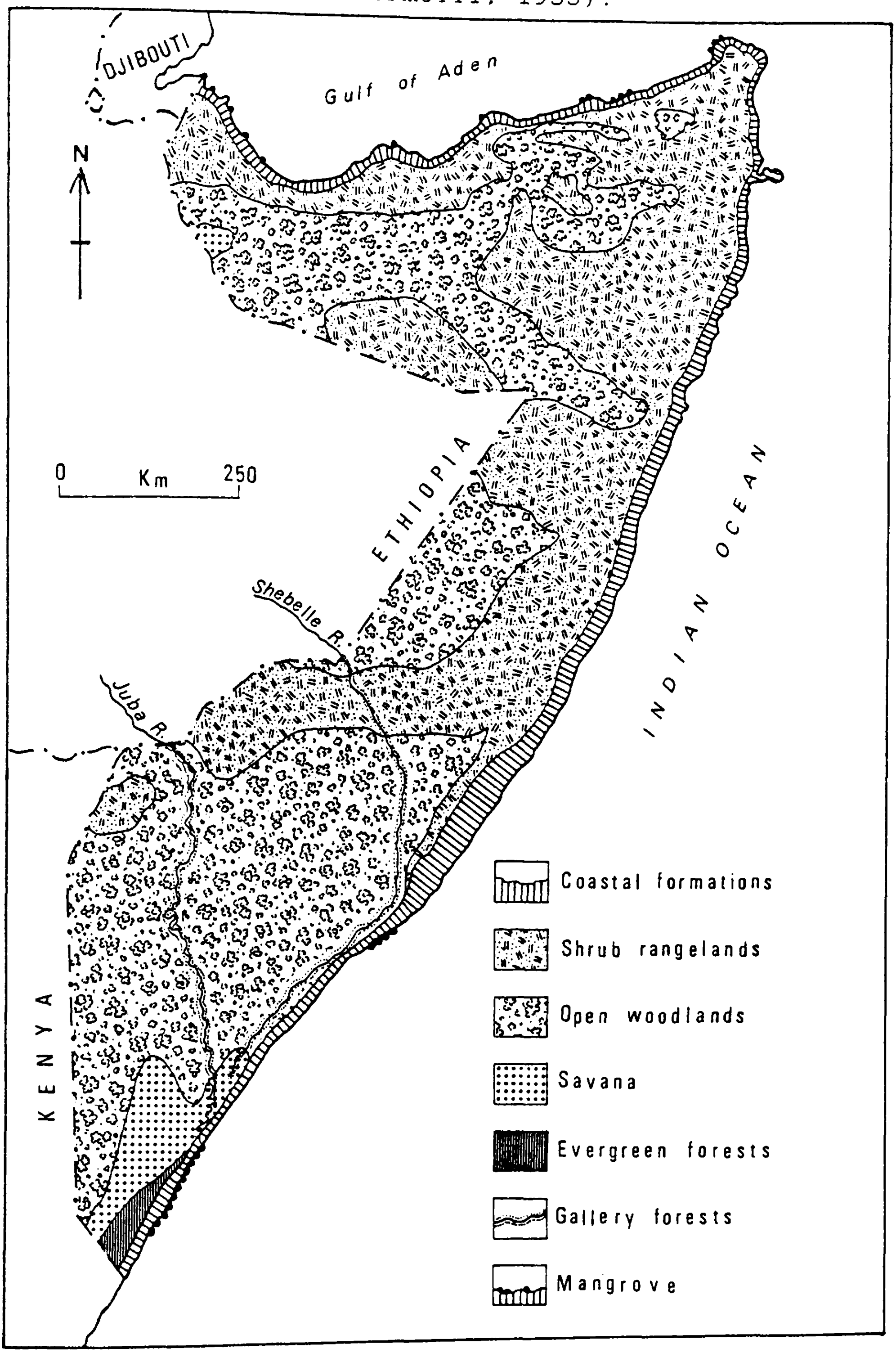
Figure 1.1: Annual rainfall ischyets (mm) in Somalia (after Ministry of Education, 1973).



such as the northern parts of Somalia by Macfadyen (1950), Hunt (1951), Gilliland (1952), Greenwood (1957), Boaler and Hodge (1962) and Hemming (1965, 1966). Range cover may generally be classified into two belts: shrub rangelands and open woodlands (Figure 1.2), both of which are related to the rainfall regimes and to some extent to soil types. Shrub rangelands mainly consist of scattered small shrubs such as Acacia edgeworthii and A. somalensis, with sparse annual grasses. This type of range vegetation is mostly used for the grazing of goats, sheep and camels. The open woodlands include an open assemblage of bushes like Sansiuera stuchyi and Euphorbia breviarticulata, with scattered trees such as A. bussei, A. tortilis and A. etbaica, and annual grasses in between. This range cover is the main source of forage for cattle, as well as a source of fuelwood and timber for the local inhabitants.

The final environmental resource of the rangelands is the soil. The most studied soils are those which are used for crop production as in the range areas between Juba and Shebelle rivers of the southern Somalia (International Cooperation Administration (ICA), 1961; Vries, 1968). Consequently, there is little information on the soils used for grazing purposes, although these soils occupy a greater part of the rangeland areas compared with those soils utilized for crop production. However, most of the cultivated soils are Vertisols, since they are the most fertile soils in Somali rangelands (Hunting Technical Services (HTS), Vol. 1, 1982).

Figure 1.2: Vegetation types in Somalia (after Pichi-Sermolli, 1955).



1.3.2 Socio-economic Structures of Somali Pastoral Societies

The social and economic structures of Somali pastoral groups are in many ways similar to those which have been adopted by the pastoral societies elsewhere in Africa and Asia. The main means of production involves primarily grazing animals and rain-fed farming lands. Camels, cattle, sheep and goats are the main grazing animals owned by pastoral communities in Somalia (Hunt, 1951; HTS, Vol. 1, 1982). In fact, Somalia, or rather So-mal, means in the Somali language 'go and milk'. This etymological explanation shows the inseparable link between the Somali people and their grazing animals which has developed over many hundreds of years (Silberman, 1959). These animals are privately owned with a general estimation of about 10 cattle, 65 sheep and goats and 12 camels per pastoral household (Jamal, 1983). Livestock is a source of milk, meat and skin for pastoral families. It is also the main source of cash by selling surplus animal products and animals in order to buy household needs, such as clothes, and to pay for social obligations like bride-price (Lewis, 1969a; Swift, 1979; Behnke and Kerven, 1984). Livestock play an essential role in the economic and social life of pastoral people. Consequently, pastoral households in Somalia tend to build up the size of their herds and flocks. Karp (1960) found, from an economic perspective, an explanation for the accumulation of livestock in terms of a 'precautionary motive'. This motive is to ensure that the direct and indirect means of subsistence for the Somali pastoralists is guaranteed. The accumulation of livestock, therefore, cause these groups to be continuously preoccupied with economic security, since the availability of environmental resources, particularly range forage and drinking water, is uncertain (Konczacki, 1967).

Rain-fed farming land is of secondary importance. Nevertheless, it is significant especially among those agro-pastoralists who are mostly found in the North West region of Somalia and in areas between the Juba and Shebelle rivers (International Labour Office (ILO), 1972). These lands are operated as family units with the average size of farms ranging from about one hectare per agro-pastoral household to a maximum of about ten hectares (Haaland and Keddeman, 1984). The wide range of farm sizes is often related to marked variations in the amount and location of rainfall. The rain-fed farming lands are devoted to crop production, especially sorghum, in order to sustain household needs for cereal foods and to generate a cash return from selling the available surplus of their crops (Clark, 1968b; Al-Najim, 1982).

The household forms the basic production unit in these societies, similar to other pastoral communities in Africa and Asia. As such, household members are the main source of labour power in the production process of pastoral societies in Somalia (Lewis, 1961). Family members are together responsible for achieving their economic and domestic activities. Nevertheless, two main groups of labour can be differentiated in the pastoral household: male labour and female labour (Lewis, 1961, 1969a; University of Wyoming, Vol. 2, 1984; Massey, 1987). The work performed by family males typically includes: (1) the grazing and milking of camels and cattle; (2) the selling of stock either in small numbers in the market or in larger numbers to middlemen; (3) the harvesting of crops, and weeding when there is a shortage of female labour; (4) the selling of crops; and (5) the bartering of animals and crops when it becomes necessary for household survival. The work performed by family females is markedly different to that performed by males, and mostly involves: (1) the grazing and milking of goats and sheep; (2) the grazing of cattle when there is a shortage of male labour; (3) the carrying-out of most farming practices like farm preparation, seeding, weeding and harvesting of crops; (4) the selling of milk in small quantities in the market, and of other household products such as chickens; and (5) fetching water and collecting firewood in addition to other household chores. The division of family labour is normally determined by the head of household and, as such, insufficiency of family labour has mostly been overcome by polygamy. Nevertheless, it is common to find some individuals working as paid labour for those who have larger herds and more extensive dry-farming lands (Lewis, 1969a; International Labour Office / Jobs and Skills Programme for Africa (ILO/JASPA), 1977; University of Wyoming, Vol. 2, 1984; Massey, 1987).

The third element of Somali pastoral societies concerns geographic movements. These movements are mostly practised in order to graze and water livestock, since environmental resources are seasonally variable from one range area to another. For example, between October 1944 and March 1945, most of the pastoral movements in the northern parts of Somalia, were spread over the range areas of Haud region, owing to the availability of range forage and rainwater for drinking, while these movements were centred around watering wells in the Guban and Ogo regions from March to May 1945 (Hunt, 1951). Pastoral movements can be divided into two principal types: firstly, major movements which usually take place in those grazing areas experiencing often considerable amounts of rainfall; and secondly, minor movements which often take place in the vicinity of watering points when there is a lack of rain showers over the grazing areas. In this case, pastoral movements are greatly influenced by seasonal variations in range forage and drinking water supplies. As such, these movements are the most common form of land-use in Somalia (Box, 1971). Nevertheless, pastoral movements remain the biggest obstacle to achieving effective range management in Somalia (Nelson, 1958). In addition to the factors of the availability of range forage and drinking water, other factors affecting pastoral movements in Somalia include the need for pasture rich in salt, and the presence or absence of ticks and tsetse-fly. These factors are subsidiary, having in most cases only an irregular influence on pastoral movements compared with the availability of drinking water and range forage (Hunt, 1951; Lewis, 1965; Al-Najim, 1982).

1.3.3 Environmental Problems in Somalia

The first environmental problem of the Somali rangelands is that of excessive exploitation. Overstocking, overcutting of woody vegetation and overcultivation are the most important dimensions of the excessive use of rangelands in Somalia. These rangelands have now become been overstocked, with a rate three times the estimated carrying capacity of Somali rangelands (Field, 1980). The most obvious effect of this grazing pressure is that the perennial grasses, such as _Cenchrus ciliaris_ and _Sporobolus_, have been replaced by annuals such as _Vicias_ and _Indigoferas_, and in some cases by unpalatable species, such as _Launea cornuta_ (Hartley _et al_., 1967). Therefore, this process has resulted in a continous reduction in the production of range forage, especially in areas near watering points (Mahony, 1966).

Overcutting of woody vegetation is another aspect of excessive use of rangelands in Somalia. This problem has been discussed in several studies and reports such as those by Hemming (1966), Hartley et al. (1967), Al-Najim (1982) and Kazmi (1982). Woody plants are collected freely by the local inhabitants, to be used directly as firewood, in charcoal production and as timber for building and animal fencing. Such uncontrolled exploitation does not only deplete the potential woody resources, but also leads to an increase in soil degradation, since soil surfaces are left unprotected against erosion processes.

Overcultivation, the third aspect of excessive exploitation of the Somali rangelands, results from unsatisfactory farming systems (HTS, Vol. 2, 1983). The shifting system of cultivation is not widely practised, instead continuous cultivation is most often adopted (ICA, 1961; Lewis, 1961). Consequently, soil fertility and soil moisture content decline, while erosion processes begin to accelerate. Overcultivation has also resulted from the expansion of croplands. The field observations carried out by Lewis in 1974 in the northern parts of Somalia, showed that there were more patches of cultivation than there had been 20 years earlier (Lewis, 1975a). This suggests that range areas are being further cleared of vegetation, and therefore soil surfaces are being increasingly exposed to wind and rainwater erosion.

Drought is a significant environmental problem for the Somali rangelands. Since 1910, meteorological records, and the memory of the local inhabitants, have shown many drought conditions in the whole of Somalia in general, and in the northern parts in particular. The years 1911, 1914, 1918, 1925, 1927-1929, 1933-1934, 1938, 1943, 1950-1951, 1955, 1959, 1965, 1968-1969, 1973-1975 and 1979-1980 were all drought years in Somalia (Hunt, 1951; Boothman, 1975; Swift, 1977a). In general, these periods reflect the fact that Somalia is affected by at least one drought every 3 or 4 years. Consequently, drought can be regarded as a repeated phenomenon. This implies that the Somali pastoralists have to maintain larger herds and to store greater amounts of crops against drought disaster.

Desertification is an increasing problem in the Somali rangelands. In general, Somalia is affected by slight to severe processes of desertification (Dregne, 1984). It seems that these processes have resulted more from the excessive use of the rangeland eco-systems, than from the direct effects of drought. Curry-Lindahl (1974) indicated that the rangeland-use systems in Somalia typified specifically by overgrazing and overcutting of woody vegetation, have led to the acceleration of the processes of desertification. In addition, it is suggested that the advance of sand-dunes into the southern areas of Somalia are closely related to rangeland mismanagement (Ayan, 1982). In this case, desertification processes worsen during deteriorating drought conditions and, as such, the loss of biological productivity in the rangelands increases.

The plagues of Desert locust provide an intermittent, but serious problem for the Somali rangelands. In fact, Somalia is one of the areas most affected by Desert locusts. It was reported that the annual infestations of Desert locust swarms ranged from 80 per cent in the southern areas, to 88 per cent in the northern areas during the 25-year period from 1939-1963 (The Anti-Locust Research Centre, 1966). Over the last 20 years, there has been a general decline in the Desert locust population, owing to the effective co-operative control measurements carried out in Somalia and the surrounding countries by the Desert Locust Control Organization for East Africa (Djibouti, Ethiopia, Tanzania, Sudan, Kenya, Somalia and Uganda), and by national units such as the Somali National Unit for Desert Locust Control (Ashall and Chaney, 1982). However, despite these effective operations, some swarms of Desert locust have recently been reported in Somali, as elsewhere in Africa and Asia (FAO, 1986).

1.4 The Presentation of the Work

This thesis is presented in four parts. Part One, the introduction, is made up of two chapters. This chapter has reviewed the main theoretical and empirical studies of rangeland environments in Africa and Asia generally, and in Somalia in particular. The scope and the hypotheses of the research have also been presented here. In Chapter Two, a general description of the study area (Bay region) is presented. The reasons for the choice of this region for the case study, as well as the research methods, are also discussed.

Part Two comprises five chapters, all of which are concerned with a descriptive analysis of land-use patterns and the main changes over the last 20 years. Chapter Three contains a general overview of land-use patterns in the study area, the main sources of information being government publications and those by private organizations. Chapter Four discusses rangeland use for grazing purposes. In-depth discussions on livestock population and ownership, herd structure and size, livestock movement and distribution, livestock sales and slaughter, as well as livestock problems, are presented. Pastoral farming practices on the rangeland are the subject matter of Chapter Five. Here, the dry-farming areas, crop management techniques, sizes of farms, types of crops, the marketing of crops and the problems of crop production are discussed. In Chapter Six the issue of wood collection on the rangeland is treated. Discussions on the uses of collected wood, which include cooking, building and charcoal production, are presented. Chapter Seven contains a discussion of the main changes in land-use in terms of selected ecological and socio-economic factors, as well as the interrelationship between these changes during the last two decades.

Part Three constitutes three chapters, all of which are concerned with attempting to explain the main changes in land-use over the past 20 years. Chapter Eight examines the ways in which environmental factors like climate, vegetation and soil, have affected changes in land-use. The focus is mainly on rainfall, as this is the most variable element in the climate of semi-arid grazing lands; the annual amount of consumable dry matter available under different amounts of annual rainfall, as this is the main source of fodder for livestock; and the structure and erosion of soil as they are the main problems for soil fertility. Chapter Nine examines the consequences of water supply, veterinary services, livestock sales and slaughter, farming and wood collection on the range resources and land-use. Chapter Ten examines the influence on land-use of social practices and government plans. With regard to the social practices, the focus is mainly on the bride-price, reciprocal labour and the migration of pastoralists to town areas, while the focus on government plans covers projects of water supply, veterinary care, marketing facilities, range management and livestock cross-breeding.

Part Four comprises one chapter which presents the conclusions of this work, as well as recommendations for possible action and future work.

CHAPTER TWO

THE STUDY AREA AND METHODS

2.1 The Study Area

The area selected for study is located in the centre of the southern part of Somalia, between the Juba and Shebelle rivers (Figure 2.1). It is called Bay region and is surrounded by Gedo, Bakool, Hiran, Lower Shebelle and Middle Juba regions. This region covers about 40,000 square kilometres between latitudes 1^0 30' and 3^0 30' N; and between longitudes 42^0 30' and 44^0 35' E. Bay region comprises the four administration districts of Baydhabo, Bur Hakaba, Dinsoor and Kansadheere, but the exact boundaries of these districts are not clearly defined on any existing map owing to the poor cartographic services in Somalia.

Physically, the study area is a low plateau sloping from more than 600m in the north to less than 100m in the south-east (Figure 2.2). The region is a relatively featureless plain with a few isolated small hills (buro) which rise abruptly from the surrounding plains. These hills mostly consist of granitic rocks, such as Bur Dinsoor (630m) in the west, Bur Dur (484m) in the central area and Bur Heybo (558m) in the east. In addition to these hills, Figure 2.2 shows some drainage channels in the central part of the region. These are generally at depths of about 4 metres and widths of about 10 metres.

The geology of Bay region is dominated by two major stratigraphical units: firstly, the Precambrian basement complex which mostly comprises quartzite, schist, granite,

Figure 2.1: Location of the study area.

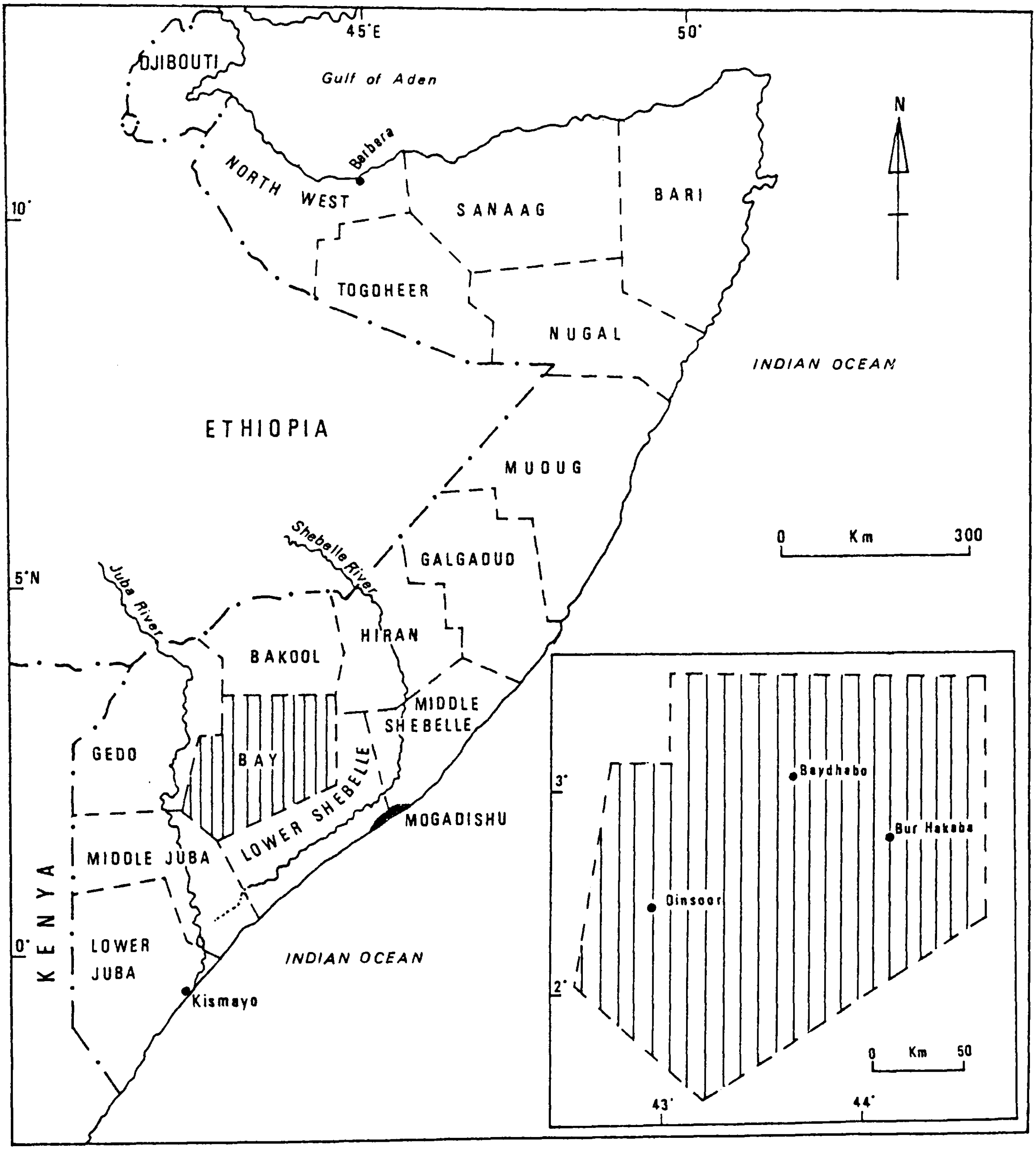
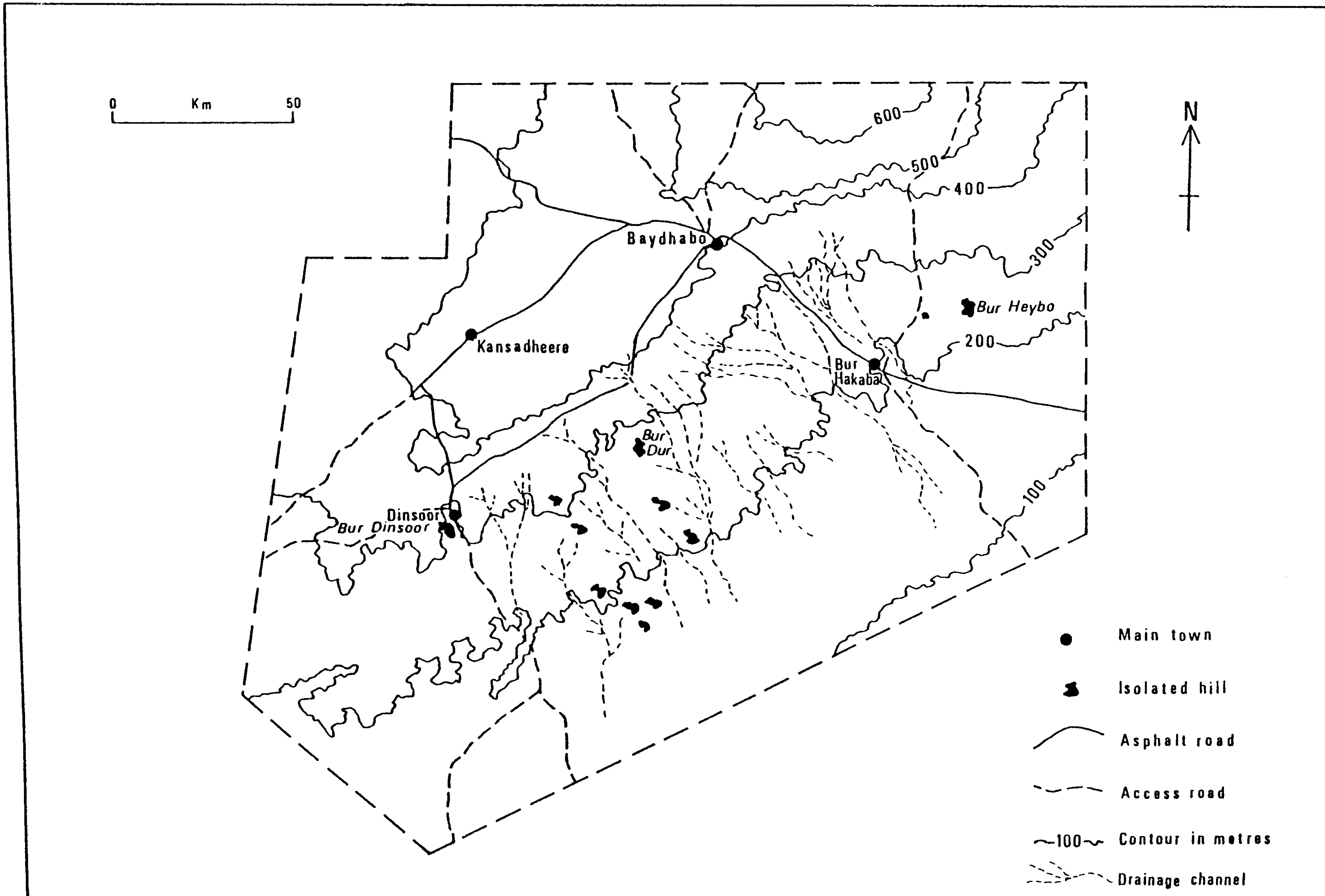


Figure 2.2: Topography of Bay region (after Resource Management and Research, 1984).



and other igneous rocks; and secondly, the Jurassic limestone formation which consists of limestones, shales, and marls with basal sandstones and conglomerates (United Nations Development Programme (UNDP), 1973). This geological structure is reflected in the surface deposits and aquifer systems. In respect of surface deposits, there are various types, but the main ones are of clay and sandy materials, or of stony and gravelly materials. Clay soils are found over vast areas and often are mixed with loam and sand. Sands occur over extensive stretches in the central and southern areas. Large areas are stone covered, having a surface of limestone boulders and polished gravels. These surface materials and soils are chiefly derived from the limestone plateau and basement complex. A description of the classified soils of Bay region and the surrounding areas was given by the ICA (1961) and this was later expanded by Vries (1968). In addition, Hunting Technical Services (Vol. 1, 1982) produced a more detailed description of classified soils in Bay region alone. The soil types, classified into fourteen units, are listed in Table 2.1, and they are named after the places and localities where they were first identified. The soils used for farming practices have been described in greater detail compared with those used for other purposes, like grazing. The present study has attempted to group the 14 soil types into four main classes according to their general characteristics, viz: Vertisols, Regosols, Latosols and Solonetz (Table 2.1). The distribution of these soil classes is shown in Figure 2.3.

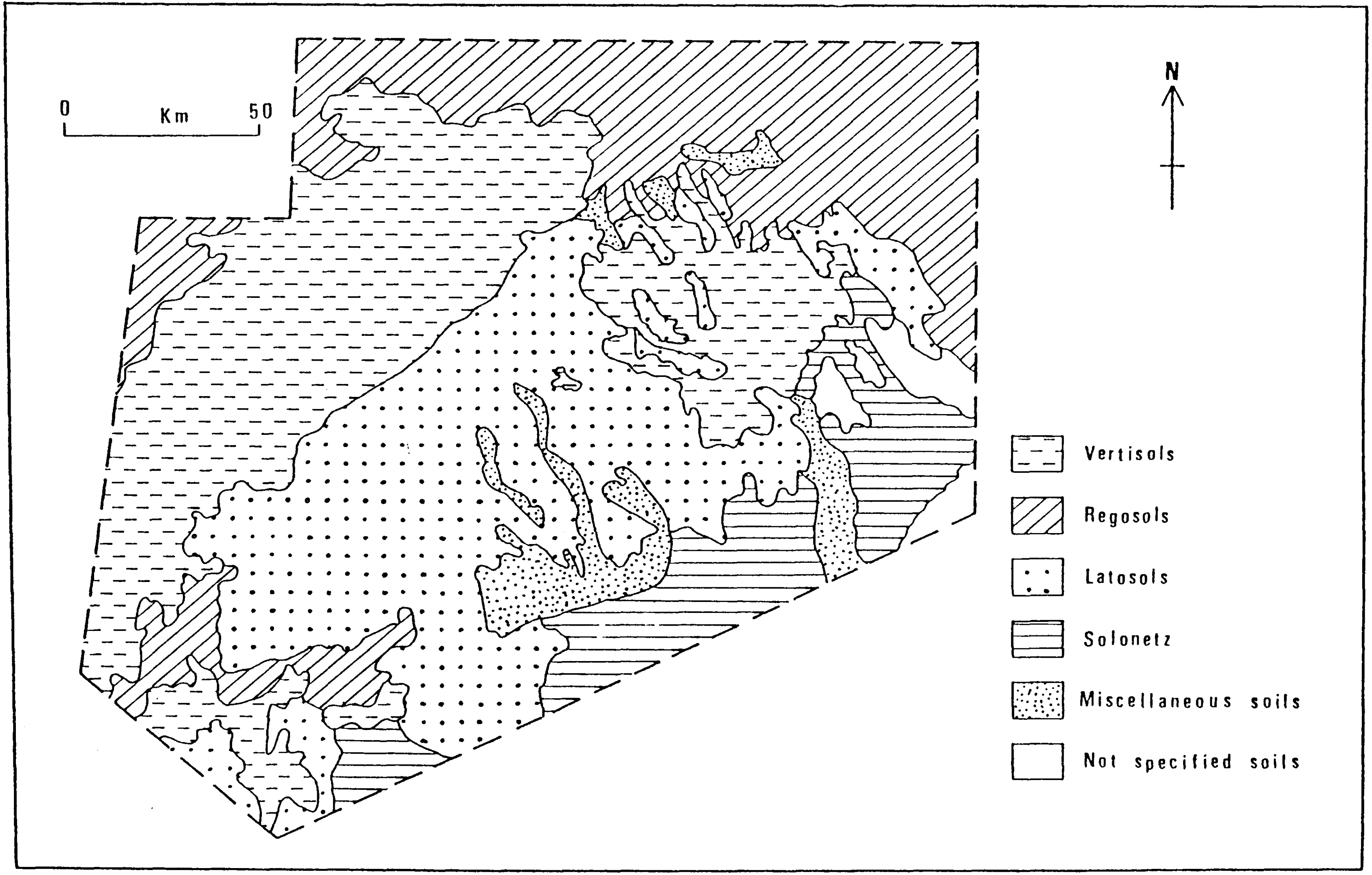
Table 2.1 Soil taxonomic units according to the fourteenth soil types and their main use in Bay region.

Soil taxonomic unit	Soil type	Main type of use
Vertisols	Amin	Cultivated
	Baidoa	Cultivated
	Uiamo	Cultivated
	Bur Acaba	Cultivated
	Modu-Mode	Cultivated
Regosols	Regosols	Grazing
	Berdaale	Grazing
Latosols	Dinsor	Grazing
	Issure	Grazing
Solonetz	Burei	Grazing
Miscellaneous soils	Asharaw	Grazing
	Valley bottom	Grazing
Not specified soils	Madamrodi	Grazing
	Dududmai	Grazing

Source: Derived from HTS (Vol. 1, 1982).

Vertisols: These soils include Amin, Baidoa, Uiamo, Bur Acaba and Modu-Mode soils which cover about 740,750 hectares, accounting for 18.5 percent of the region (HTS, Vol. 1, 1982). Their elevations vary; Baidoa and Amin soils are at about 400 to 500 metres; Bur Acaba and Modu-Mode

Figure 2.3: Soil taxonomic units in Bay region (derived from HTS, Vol. 1. 1982).



soils are found at 150 to 350 metres, and Uiamo soils lie at an elevation of 200 to 400 metres. The soils are dark brown in colour, having a uniform fine texture of clay loam or clay. They are often deep and moderately alkaline (pH values range from 7.5 - 8.0). The surface exibits a light microrelief, soft-mulching, slow permeability in the wet seasons and wide cracks during the dry seasons. The top soil is non-saline, but salts, soft calcium carbonate and occasionally gypsum and sodium are found in the subsoil. Most Vertisols are cleared of vegetation and used for rain-fed cultivation since they are generally the most fertile soils, especially when affected by annual rainfall amounts of more than 300 mm.

Regosols: These soils are mostly found in the extreme north western, north and north eastern parts (Figure 2.3), occupying about 35 per cent of land area of Bay region, with elevations ranging generally from 200 to 600 metres. They are red brown in colour, having a medium texture of sandy loams or sand clay loams. These soils are often shallow and slightly alkaline (pH values range from 7.0 - 7.5). Carbonate concentration and gypsum crystals may also be found in the subsoil. They bear medium density vegetation types of mixed shrub/bush with various herbaceous species such as Dactyloctenium aegyptiacum and D. scindicum. Limestone boulders and polished gravels are features of the Regosols' surface. Therefore, these soils are more useful for grazing than farming.

Latosols: Approximately 30 percent of the region's land area are covered by latosols, such as Dinsor, and Issure soils. Dinsor soils lie at an elevation of about 100 to 300 metres, while Issure soils occur at an elevation of about 100 to 150 metres. These soils are dark red in colour and are coarse in texture. They are often deep and slightly acidic (pH values range from 6.0 - 7.0). In many areas, they have been exposed to erosion processes. The main factor enhancing erosion is that the vegetation cover has been overgrazed, especially the herbaceous species, and, as such, there is usually considerable run-off, even after light showers. At the bottom of the valleys, the soils which are made up of the accumulation of the coarse quartz grits, are quite loose and have high permeability. Wells can easily be sunk in the bottom of these valleys to the water table which usually lies about 2 metres below the surface. Latosols support a mixed shrub/bush vegetation and they tend to be used as grazing land because of their deficiency in nutrients and low organic matter content required for cultivation.

Solonetz: These soils are found in the southern areas (Figure 2.3), occupying about 12 percent of land area of Bay region. They lie at elevations between 80 and 100 metres. They are brown to yellow brown in colour, have a fine textured clay loam or clay, and are often deep and moderately alkaline (pH values range from 7.5 - 8.0). The surface exhibits a slight microrelief and is covered with a shallow soft mulch. Soft carbonate concentrations and salts are often found in the subsoil. These soils support vegetation used for grazing since they possess little potential for cultivation.

The geological structure of Bay region provides a series of aquifer systems which meet the water demand of local people and their animals, mainly during the dry months, such as Jilaal season. Groundwater in Somalia in general, and in Bay region and the surrounding areas in particular, have been well studied by Dixon (1968), UNDP (1973), Louis Berger International (1983) and HTS (Vol. 3, 1983). Bay Region's ground water has been divided into two main aquifer systems. Firstly, the limestone aquifers which lie at a depth of 150 m or less, with water levels at 50 - 100 metres. Secondly, the basement complex aquifers which can be found at depths of 25 - 30 metres with a water level of 10 - 15 metres.

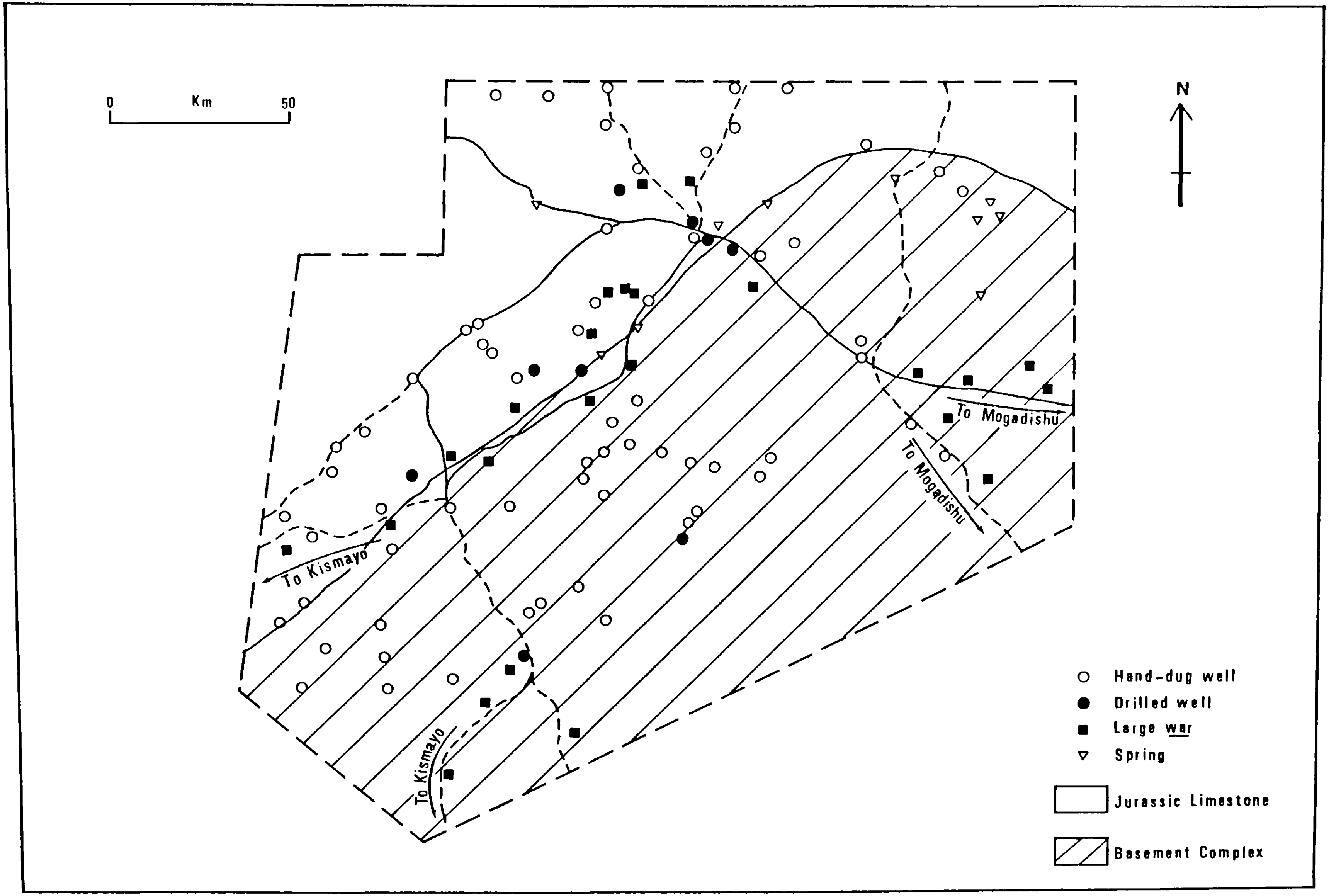
Groundwater in Bay region is exploited by excavating wells (ceelal), although, in some areas it appears naturally in the form of springs (isha). In respect of wells, they are mostly hand-dug to depths of 5 - 20 m (Plate 2.1). The number of these shallow wells in early 1982 was estimated to be about 10,000 (HTS, Vol. 2, 1982). The geographic distribution of such wells is generally uneven (Figure 2.4) and as such it is common to find several wells in a single location. The main reason is that these wells have been mainly constructed in areas where ground water of adequate quantity was found to be available at relatively shallow depths. Consequently, less effort and cost were required to dig shallow wells to draw off water.

In addition to these shallow wells there are some deep wells, with depths of 60 to 120 metres. The number of these drilled wells is unknown, but only 23 have been equipped with diesel-driven pumps under the control of the government. There are also some springs, found mostly to the east of Baydhabo. The total number of springs is unknown, but only twenty have been reported as having perennial water available.

Bay region is part of the tropical semi-arid zone according

Plate 2.1 An almost bare overgrazed area with men and women drawing water from a hand-dug well for their own use. The well is shallow, ranging in depth from 5 to 20 metres and an essential source of water during the dry seasons.

Figure 2.4: Perennial water points in Bay region (after HTS, Vol. 3, 1983).



to Meigs's definition (1953). It is characterized by marked annual variations of rainfall in terms of amount, timing and local distribution. Mean annual rainfall within Bay region and the surrounding areas generally ranges between 200 and 600 mm (Figure 2.5). Consequently, the study area is a part of the Sahelian zone between the Sub-Saharan zone to the north and the Sudanian zone to the south (Whyte, 1966; Grove, 1978). Most of the rainfall occurs in four months: April, May, October and November. For example, Figure 2.6 shows that the first two months (April and May) include about 45 percent of the mean annual rainfall at Baydhabo station, whilst 38 percent occurs in the second two months (October and November). There is no even geographic distribution of rain over Bay region; consequently, areas only a few kilometres apart may receive vastly different amounts of rainfall in a given month, season or year. Thus, fluctuations in rainfall can have a great effect on the productivity of rangeland in terms of the availability of drinking water, range forage, fuelwood, timber and crop production. Temperatures are much less erratic, with mean monthly temperatures ranging between 24.3^{0} C in the coldest month (August) and 28.6^{0} C in the warmest month (March). Temperatures therefore, do not play a marked role in the local division of seasons. The year, therefore, is divided into four seasons according to rainfall pattern alone. These are:

<u>Gu</u> (April - May), heavy rains.
<u>Hagai</u> (June - September), slight dry season.
<u>Dayr</u> (October - November), light rains.
<u>Jilaal</u> (December - March), hard dry season.

This calender shows each wet season followed by a dry

Figure 2.5: Annual rainfall isohyets (mm) 3 in 4 years in Bay region (after HTS, Vol. 1, 1982).

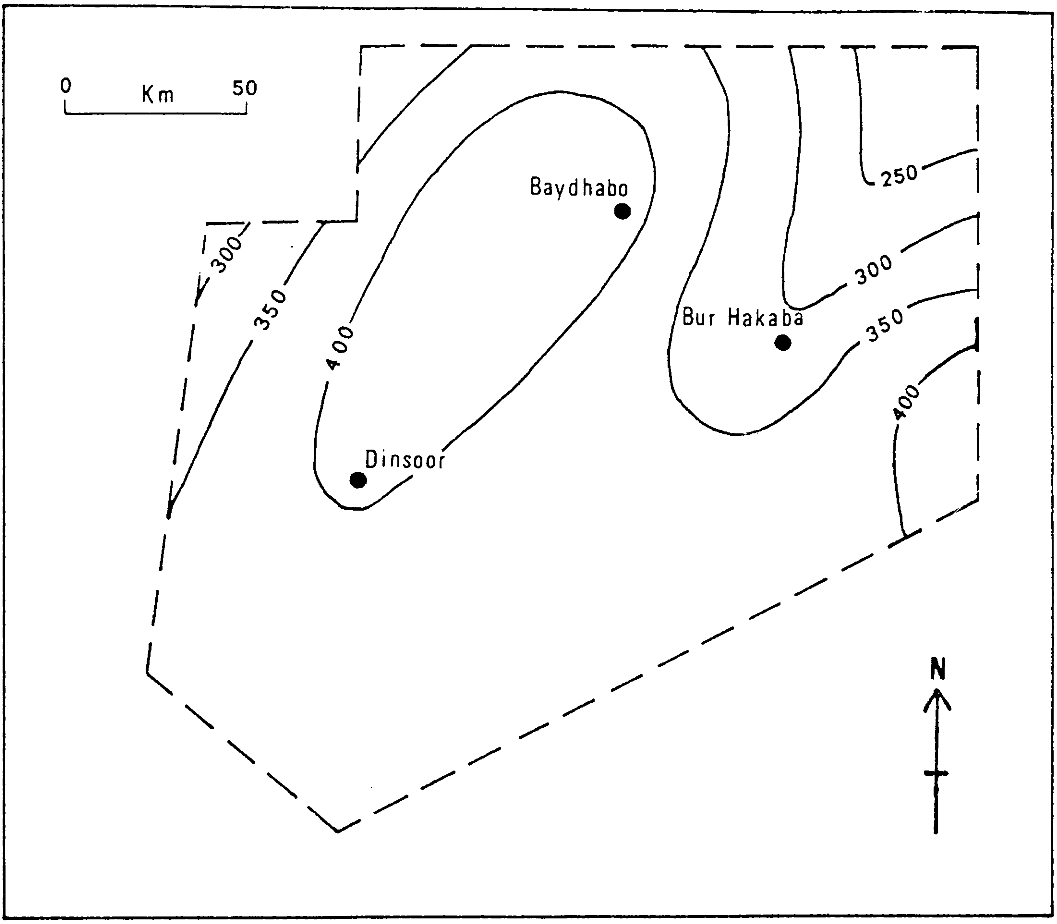
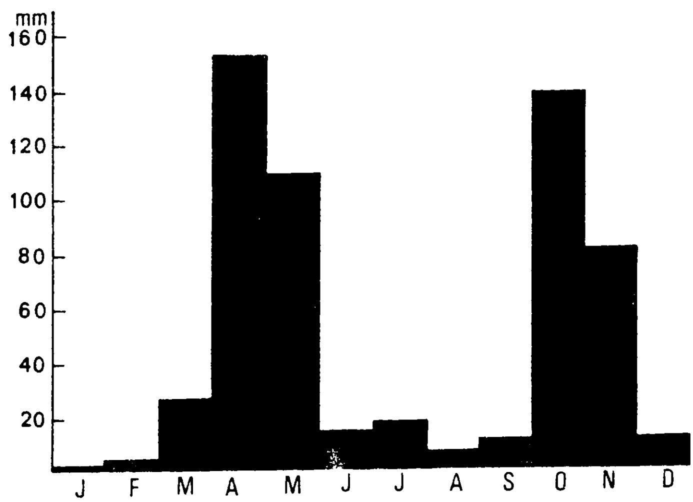


Figure 2.6: Mean monthly rainfall at Baydhabo station.



season. In fact, each of two rainy or dry seasons are not identical, for the heavy rains (Gu) are followed by a slight dry season (Haqai), while the light rains (Dayr) are followed by a hard dry season (Jilaal). In the latter case, the failure of the light rains and then a prolonged dry season are not unusual. Nevertheless, the rains play a substantial role in the social and economic life of the local inhabitants since it is not only the most important source of drinking water for both humans and livestock, but also supports the range vegetation crucial for grazing purposes.

Rainwater for drinking is mostly obtained from hand-dug ponds (waro) which are excavated in low-lying areas to a depth of about two metres. Rainwater is channeled to the war (singular of waro) through natural and hand-dug canals called ilo. The storage capacity ranges between 100 and 1,500 cubic metres of rainwater per war. These waro are mostly owned by groups of households, with 60 households generally being a maximum. To maintain its right to the use of war water, each household is required to take a share of cleaning silt from the war itself and its feeder canals. The majority of waro dry up in the dry seasons, mainly during the hard dry season of Jilaal. As well as uneven rainfall, silt is a major problem for waro since anything up to one metre in depth of silt has to be removed at least once a year (Plate 2.2). Evaporation and seepage are also considered serious problems for waro. The problem of evaporation has in some cases been reduced by surrounding waro with Euphorbia trees which can reduce evaporation through increased shade. In addition, being succulents, the trees consume little moisture. Euphorbia hedges provide an extra benefit by preventing domestic animals from entering

Plate 2.2 Dried up war at the end of the Jilaal season. It is surrounded by *Euphorbia* trees and shows deposits of silt on ground surface.

the war, and, as such, the water is kept clean. Nevertheless, the risk of pollution is still high in most waro, owing to the entry of people inside the waro to fill their containers. The problem of seepage seems to be controlled by establishing most waro on the Vertisols which have greater impermeability than other soils. The number of waro in early 1982 was estimated to be about 9,000 (HTS, Vol. 2, 1982), and these were mostly found on the cultivated areas where the agro-pastoral communities were to be found.

In addition to those domestic waro, there are 24 large waro, constructed in 1973 - 1974 by the European Economic Community (EEC) on the major livestock routes to the markets of Mogadishu and Kismayo (see Figure 2.4). Each of these has a capacity of more than 20,000 cubic metres and a depth of about 6 metres (Plate 2.3). They have barbed-wire fences in order to prevent unwanted intrusion by humans and animals. Pumping systems deliver water into eight concrete troughs located outside the fenced areas, and the waro are lined with heavy plastic sheets to prevent water losses through seepage. Nevertheless, about half of these waro were not functional at the time of the 1984 field survey, due to the breakdown of water pumps and damage to the plastic sheets and the barbed-wire fences.

The vegetation of Bay region has been classified according to Pichi-Sermollis's definition (1955) as a part of the xerophilous open woodland of the semi-arid zone in the Horn of Africa and East Africa. This definition bears some resemblance to the definition of Merritt (1968) by indicating that the inter-riverine rangelands between the Shebelle and Juba rivers, including Bay region, is covered by the semi-arid tree and shrub steppe. The latter

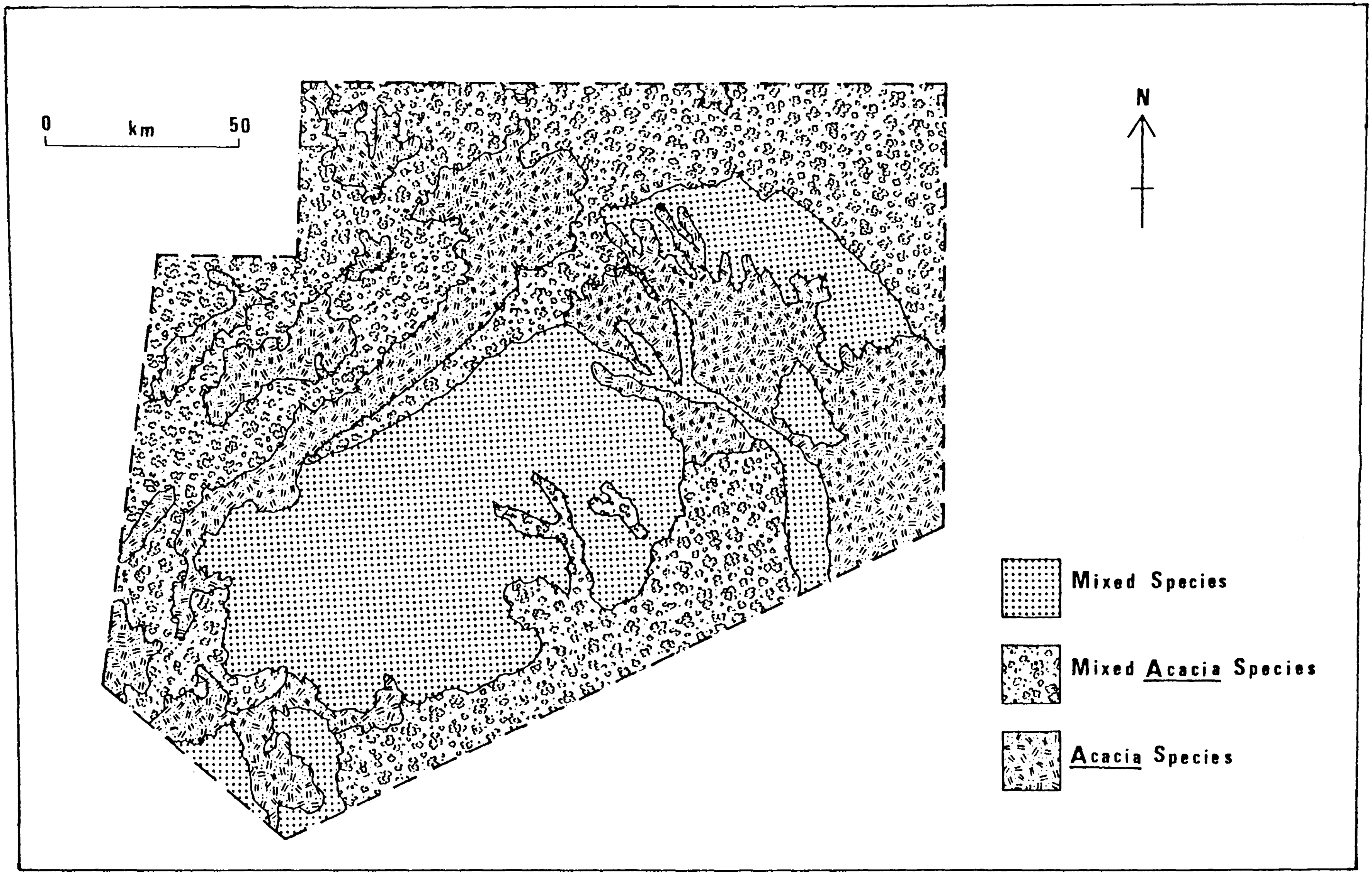
Plate 2.3 A large war with an approximate depth of 6 metres used to collect rainwater and supplied with a pumping system. Although almost at the end of the dry season (Jilaal) there is still quite a good supply of water from this war. It is one of the 24 large waro, which were constructed by the European Economic Community in 1973-1974.

classification has been confirmed in the 1982 Hunting reports, by declaring that about three-quarters of Bay region's land possess a semi-arid tree and shrub steppe. This formation is composed of various species of vegetation, including mainly Acacia, Commiphora, Euphorbia, Cassia, Cadaba, Dobera, Cissus and Terminahia, with grassy glades. These woody species are largely drought-resistant and grow in three different forms: shrubs with heights less than one metre; bushes with height ranges from one to three metres; and trees that are more than three metres high. The vegetation cover in Bay region was described briefly during the 1950s and 1960s (for example, Pichi-Sermolli, 1955; ICA, 1961; Merritt, 1968). These studies catalogued the names of important species of trees, bushes, shrubs, grass and herbs, but without any indication as to their distribution. Therefore, the information included in these studies is less helpful than that of the Hunting (Vol. 1, 1982) discussion. Accordingly, the 1982 Hunting Survey stated that more than two-thirds of the region's area show a sparse to medium density of vegetation cover. This report also devised a general system of woody species' composition by identifying three main units in Bay region (Figure 2.7), these being:

(i) Mixed Species: this unit covers about 38 percent of the study area and, among the vegetation, are many poor species of plants with a high proportion of unpalatable types owing to overgrazing. It would appear that this unit occurs mainly on the Latosols in the central rangelands of the region.

(ii) Mixed Acacia Species: this unit covers about 33 percent of the region with numerous species of Acacia. Consequently, it is preferred for charcoaling. This type is mostly found on the Regosols and Vertisols in the north, north-east and

Figure 2.7: Vegetation units in Bay region (after HTS, Vol. 3, 1982).



north-west of the region.

(iii) Acacia Species: this unit occurs over the smallest area with about 29 percent of the total land. It includes coarse Acacia thickets found growing on the abandoned farming fields on the cultivated Vertisols.

Bay region is occupied by some of the Rahanweyn groups. Rahanweyn means "a large crowd" but the alternative derivation refers to the "mixed economy of animal grazing and crop farming" (Lewis, 1969a). The Rahanweyn groups have followed this method of economy for many generations. These activities are not only practised to satisfy the subsistence needs of the pastoral household, but also to generate cash for buying household necessities like sugar, tea and clothes, as well as paying bride-prices and fines. Consequently, livestock husbandry and dry-farming are considered to be the foundation of Rahanweyn groups in Bay region and the surrounding areas.

No accurate census has yet been undertaken in Bay region. However, the 1975 National Census estimated the total population of the region to be 393,153 persons, about 8.9 per cent of the total population of Somalia (CSD, 1983). In 1980, Bay region's population was estimated by the Somali government to be about 450,986 persons. In this case, the annual rate of population growth is about 3 per cent over the 5-year period from 1975 - 1980. This percentage is quite similar to the annual rate of growth of Somalia's population as a whole (CSD, 1983, 1984).

The 1975 population of Bay region has been divided by the Somali government into three economic groups; viz, agro-pastoralists, nomadic pastoralists and town dwellers. The agro-pastoralists are the largest group constituting about 54 per cent of the study area's population. About 31 per cent of the region's population are nomadic pastoralists and only about 15 per cent are town dwellers (CSD, 1984). This division shows again the prominent position of the agro-pastoral economy in Bay region in which part of the land is individually used for farming while the rest is communally used for grazing. This type of economy has led to the adaptation of a split family system, whereby family members are divided into two management groups. One group remains at the homestead undertaking farming activities, while the second group is involved in grazing practices. Nevertheless, family members can be interchanged, when necessary, to meet the varying subsistence needs and labour requirements of each group (University of Wyoming, Vol.2, 1984).

Bay region was chosen for the case study of rangeland use in Somalia for two main reasons:

Firstly, Bay region is representative of Somalia's rangelands, in that it is heavily dependent on an agro-pastoral economy for its prosperity. Its environmental resources, particularly rainfall, and its location in an area of transition between the hinterland of pastoral nomadism in the north, and the riverine lands of sedentary tillage in the south, have exposed it to the combination of most, if not all, of the practices that have been adopted by Somali pastoral groups in the use of rangeland ecosystems for both grazing and farming purposes, and for fuelwood and timber production. Therefore, Bay region is typical of rangeland environments and their uses in Somalia.

Secondly, Bay region is one of the Somali rangeland areas which has attracted considerable attention and aid from the Somali government, as well as other international organizations, such as EEC, in the development of the range resources since the 1950s. Investments in this region by both the Somali government and the international organizations can be attributed to the high agricultural potentials in the region which, if properly developed and managed, could contribute greatly to the economy of both the region and the entire country. Also, the fact that Bay region is situated not too far away from Mogadishu (about 300 Kms) where the Somali Government Departments of Agriculture, Livestock, Range Management and Planning are located, ensures that government acceptance of development projects in the region is relatively easy. The impact of such development is seen mainly in the increase of watering points, livestock marketing, and dry-farming lands. This has consequently brought about some changes in the pastoral ecosystem the effectiveness of which this study seeks to establish.

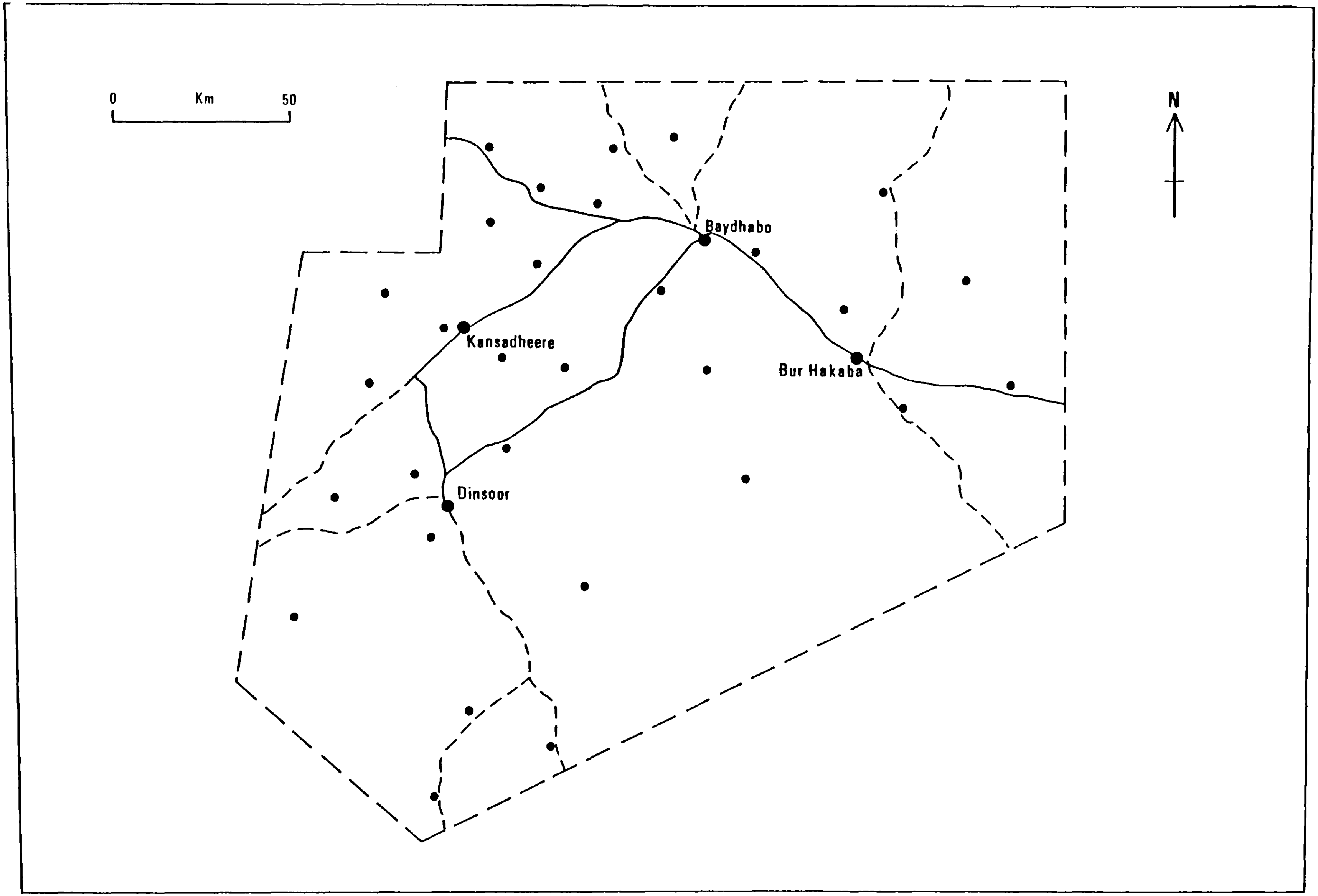
2.2 Methods

The objectives and the design of the study necessitated the use of several methods of data collection. These methods included a structured questionnaire survey, informal discussions with local people and government officials, field observations, published and unpublished records from the Somali government and international organizations, Landsat images and photographs. Of these methods, the questionnaire survey relied most upon obtaining basic information on pastoral land-use patterns and the changes in the pastoral ecosystem. The questionaire was divided into five sections (Appendix 1). The first section was devoted to the socio-economic characteristics of the head of household. This is necessary because in a male-dominated society like Somalia, the family practices, such as grazing and farming, are mostly determined by the head of household. This section also included some questions relating to the demographic composition of the household, such as the number of household members working in towns within or outside Bay region. The second section was designed to establish the nature of livestock management, and focused on variables such as ownership, sales, slaughter rates and livestock problems. The third section covered farming practices, focusing on crop composition, marketing and associated problems. The fourth section was concerned with firewood and timber collection for domestic purposes as well as the sale of firewood. With the main pastoral land-use patterns covered by section two to four, section five was then directed at the changes in the main ecological and socio-economic variables such as rainfall, vegetation, the number of livestock and changes in areas of dry-farming land over the last two decades.

The questionnaire contained 34 questions, some of which were made up of several parts. The design of most questions was such that they related to the experiences of the pastoralists in land-use. Opinion questions, relating to land-use, were also asked, and those questions were structured so that the technique of point score analysis could be used. The implementation of the point score technique was such that in answering the questions, the pastoralists had an opportunity to choose one of five standardised scores. The grading system for the answers was a 5-point scale, 0 - 4, with zero corresponding to very unimportant, not serious at all or disagree strongly, depending on the option in a particular question, and 4 corresponding to very important, very serious or agree strongly, as the case may be in the question. The numbers in between were interpolations between these two extremes. This technique is very appropriate for the analysis of data collected in a study of this nature, since it involves three degrees of comparison: negative, neutral and positive; and the Chi-square statistic can readily be used as the test statistic for such data (Briggs, 1984). In addition, the pastoralists had a chance to indicate whether or not there were other variables or problems which were not mentioned with reference to a particular question. This method enabled the researcher to find out as much as possible about problems and variables relating to land-use patterns.

The field work was undertaken from January to October 1984 and the questionnaire survey was carried out during two separate periods. The first (February - April) was during the <u>Jilaal</u> dry season, while the second (June - August) was during the <u>Gu</u> rainy season. This procedure enabled the researcher to collect a full range of information on the land-use patterns in the rangelands during two contrasting seasons. The questionnaire was administered on a total of 240 households in the region. In this case, about six per thousand of the region's pastoral peoples were interviewed. This is estimated from the average family size of the Somali pastoral groups which is approximately 8 persons per household (ILO, 1972), and the population of pastoral inhabitants in Bay region which is about 334,180 (CSD, 1984). These 240 households, picked from 30 settlements, were chosen from random points located within the study area (Figure 2.8). In practice, there was great difficulty in

Figure 2.8: Location of the 30 stands sampled in Bay region.



reaching the chosen points due to lack of access routes, and therefore it became necessary to interview pastoral households in settlements as near as possible to the chosen areas. A total of about 180 days was spent in these settlements interviewing the 240 households. Eight households were interviewed in each of these 30 settlements and in practice four were interviewed during the dry season Jilaal while the other four were interviewed during the rainy season Gu. This division was carried out in a careful way in order to avoid the reinterviewing of the same households during the second survey (Gu season). The eight households were mainly selected by virtue of their locations in the surveyed settlement. The household which was counted as the first household sampled and the next as the second and so on. Thus the first to the fourth households were interviewed during the first survey while the fifth to the eighth households were interviewed during the second survey.

The questionnaire survey was carried out with the assistance of two competent officers of the range management and veterinary department in Baydhabo. These two officers had a good knowledge of the region and were familiar with its inhabitants. They were very helpful in posing the questions to the interviewees in the local dialect and marking the given answers accordingly. The interviewed households were generally co-operative, although there were six refusals. Such a lack of co-operation was mainly encountered during the first survey and was seen to be a reaction to the pressure on the pastoralists at that time of year, due to the lack of drinking water for both their families and livestock.

Informal discussions were another valuable method of collecting information. Discussions were held with local inhabitants and government officials at both individual and group levels. Discussions with local inhabitants in the surveyed settlements were mainly held in small groups. The men in these groups were those who actively participated, while the women and children only listened. The topics discussed covered issues such as livestock management which included grazing, watering, breeding, milking, weaning, marketing, slaughter, stock identification and health; crop management, which looked into field preparation, crop breeding, planting, spacing, thinning, weeding, harvesting, sorting, storage, marketing, and crop pests and insects; wood collection for cooking and building as well as local selling; government services such as veterinary, agricultural, water supply, grazing reserves, schools and medical care; charcoal production where aspects of production, transportation and marketing were explored; the main environmental threats to economic activity such as drought and locusts; sources of water supply whether <u>waro</u>, wells or springs and the domestic adminstration of <u>waro</u> and wells; the overgrazed plants, as well as bush/tree species used for cooking and building; the main divisions of family labour for grazing, farming and other household activities; reciprocal labour; hired labour; bride-price arrangements; a polygamous system; and the migration of pastoral people to the neighbouring urban areas. From these discussions many useful ideas and insights were obtained about the social and economic life of the local inhabitants.

Discussions with governmental Ministry officials provided much additional information, in relation to the tasks of those offices in developing the productivity of rangelands and in improving the pastoral economy and the social life of the local people. These discussions were mostly held in Baydhabo, Bur Hakaba, Dinsoor, Kansadheere and Mogadishu with the relevant departments such as Agricultural Extension, Range Management, Veterinary Services, Plant Protection and Agricultural Research. The discussions focused on what these departments had done so far, and what projects were currently taking place. The difficulties included insufficient numbers of vehicles and lack of spare parts, fuel shortages, lack of sufficient trained personnel and poor financing.

The third method of data collection was field observations. Both environmental and socio-economic phenomena were observed in this process. The observed environmental phenomena were mainly the after-effect of soil erosion in the dry farming areas, around the watering points and on the roads and tracks. Also, the vegetation cover around the surveyed watering points was noted. The main observed socio-economic phenomena were the roles of women and children in the land-use activities such as smallstock grazing, firewood collection and fetching of water. The sizes of farms, the geographic patterns and condition of crop storage facilities, the conditions of waro as well as the shape and structure of housing were also observed. Again, the marketing operations, including those on livestock, crops, milk and firewood, constituted data of interest. Stocks of commodities sold by food shops in the pastoral settlements were closely observed. From these observations many useful pieces of information were derived and used in the descriptions presented in the different sections of this work.

The fourth source of data collection was the published and unpublished records from the Somali government and other individual organizations, such as Hunting Technical Services and University of Wyoming. These records were only available for certain areas of the research, such as in the study of the vegetation and soil, the socio-economic aspects of local inhabitants, the number of exported live animals and the various development plans. Even the available ones were often not complete, as some sections were reported missing and most statistical data from this source did not contribute significantly to this study.

Landsat images were the fifth method of data collection on land-use in Bay region. They were used mainly to assess changes in land-use for cultivation over a period of 12 years (1973 - 1985), as discussed in Chapter Five. The last source of information on land-use in the study area was photographs. As can be seen in different sections of the thesis, they provide a pictorial representation of most of the land-use conditions described.

PART II LAND-USE TYPES AND LAND-USE CHANGES

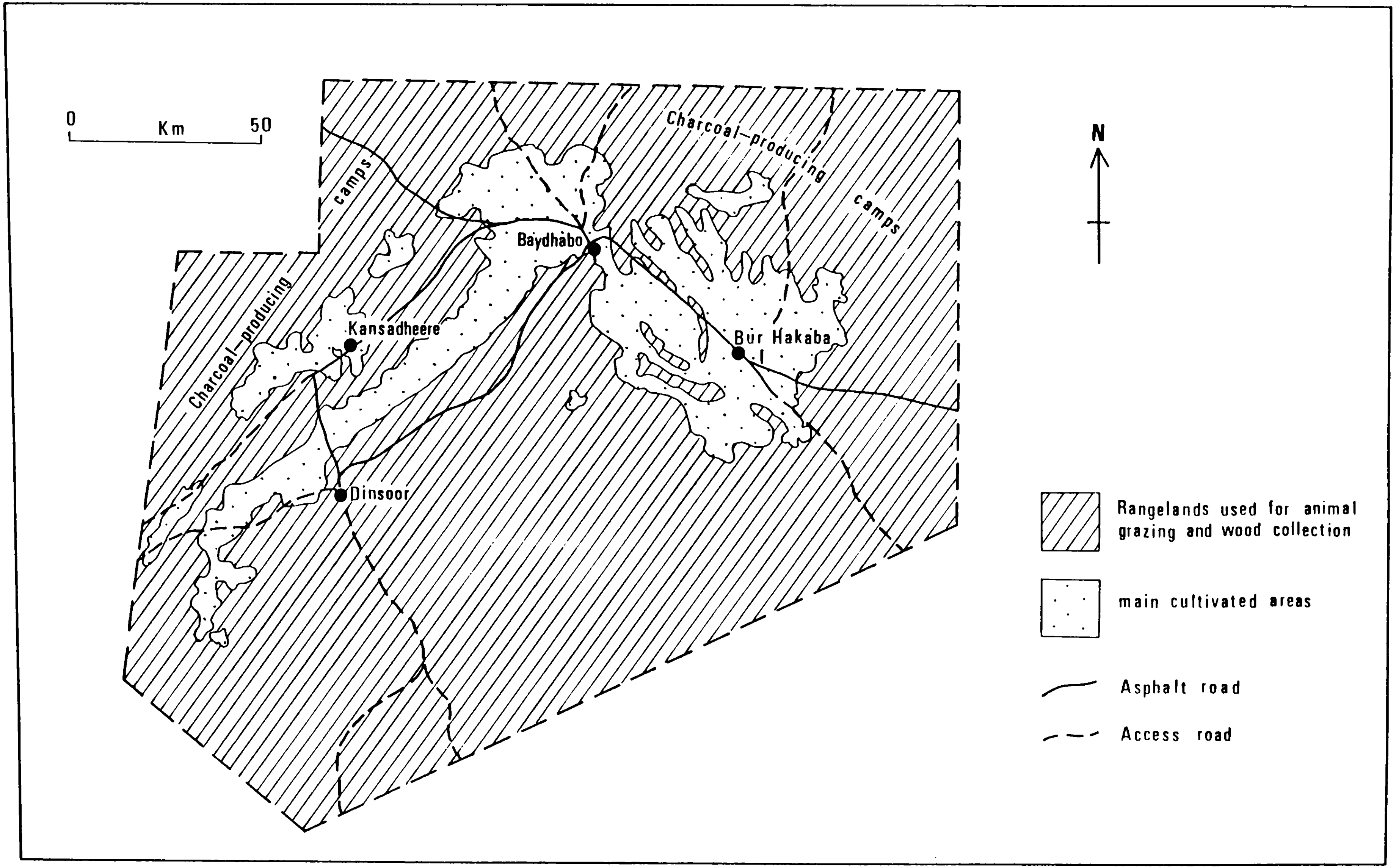
CHAPTER THREE

GENERAL OVERVIEW OF LAND-USE

In Bay region, there are three main types of land-use: animal grazing, dry-farming and wood collection. This implies that the pastoral people of the study area attempt as much as possible to vary their subsistence needs from their lands. It is necessary to depend on more than one source of subsistence in order to ensure an adequate diet, to meet the material requirements of the pastoral groups and to provide insurance against one element failing in any one year. Thus, the need for milk, ghee, meat, skin, grain, firewood and timber, as well as the desire for socio-economic gains, can only be obtained from the use of rangelands for different purposes: grazing, dry-farming and wood collection.

The land-use patterns and their general distribution over Bay region have been briefly discussed in reports published by the Somali government (for example, Food Early Warning System Department (FEWSD), 1984) and Hunting Technical Services (Vols. 1 and 2, 1982). Figure 3.1 shows that dry-farming land tends to be used only for that purpose, whilst animal grazing and wood collection practices are usually intermixed and carried out in the same area of rangelands. Consequently, there is no clear division between rangelands used for grazing and those used for wood collection purposes. This is because range vegetation is considered to constitute a substantial supply of forage for livestock and fuelwood and timber for people. However, animal grazing is practised in areas where range forage (for example grasses, herbs and fallen leaves) or crop residues, in addition to

Figure 3.1: Land-use types in Bay region (derived from HTS, Vol. 1, 1982).



drinking water, are found. In this case, most of the region's land, including the cultivated areas, can be considered as a pastureland when there is abundant rainfall.

Dry-farming is the second land-use type, but its area in Bay region has been estimated differently over the last two decades. Somali government reports estimate the area of cultivated land in 1975 to be about 142,000 hectares (Ministero dell' Agricola, 1975), and in 1979 to be about 100,000 hectares (State Planning Commission, 1979). The most recent estimation in 1984 put it at about 144,800 hectares, accounting for about 4 per cent of the total region's area (FEWSD, 1984). The HTS technical report (Vol. 2, 1982), on the other hand, estimates that the area of dry-farming lands in the region is about 445,481 hectares, accounting for about 11 per cent of the region's land. It can, therefore, be considered that somewhere between 3 and 11 per cent of Bay region land is used for dry-farming activities.

Figure 3.1 shows that the most cultivated areas are those covered by Amin, Baidoa, Bur Acaba and Uiamo soils. These clay materials are the most fertile soils in the region (see Chapter 2). Nevertheless, these cultivated lands are also affected by the existence of markets and agricultural stations in Baydhabo, Kansadheere, Berdaale, Dinsoor and Bur Hakaba; and the extension of some roads such as the Baydhabo-Dinsoor-Kansadheere-Berdaale road. Thus, agro-pastoralists can easily gain agricultural services supplied by Somali government and, on the other hand, crop production can easily be transported in order to be sold in these markets. Consequently, expansion in rangeland cultivation is reflected in the growth of the high number of agro-pastoral settlements (HTS, Vol. 1, 1982).

Wood collection is the third land-use type, being practised in those range areas covered with woody vegetation. For example, the great majority of the charcoal-producing camps are found in the northern, north-eastern and north-western parts of the region (Figure 3.1), extending into the southern parts of Gedo and Bakool regions to the north and north-west. These areas are not only covered with mixed Acacia species of good quality for charcoaling, but are also found near the high number of agro-pastoral settlements and main roads in the region. Therefore, it is easier to obtain manpower for charcoal processing and for the transportation of charcoal production to the main consumer centre of Mogadishu.

The next three chapters will go on to consider each of these land-use types in detail.

CHAPTER FOUR

LIVESTOCK GRAZING

4.1 Livestock Population and Ownership

4.1.1 Livestock Population Numbers

It is not easy to ascertain the accurate number of livestock in Bay region, nor for that matter in Somalia or even Africa as a whole. Pastoralists are reticent about revealing this type of information in order to avoid some annoyances such as 'the evil eye'. Estimates of livestock populations and their growth trends are, however, of crucial importance for the study of rangeland-use. According to the available data for livestock in Bay region (Table 4.1), it is clear that the numbers of livestock have increased during the 7-year inter-censal period from 1975 - 1982. The general trend of this increase shows that livestock numbers grew by about 3 per cent per year in terms of livestock units, a rate quite similar to the annual increase of Somali livestock numbers overall (Jamal, 1983). This trend indicates that the annual growth rate of livestock is very similar to that of the human population in Bay region, as indeed, in the whole of Somalia. Consequently, it can be argued that the increases in livestock numbers are necessary to meet the growing needs of local inhabitants for food. Nevertheless, this raises the general question of increasing grazing pressure, and, in particular, whether such annual increases in livestock population have led to overstocking.

Table 4.1 <u>Estimated livestock numbers and total livestock units in Bay region</u>.

	Camels	Cattle	Small-stock	Total livestock units*
1975	311669	254877	246645	681460
1982	321722	368065	389366	828622
Annual increase	0.4%	6.3%	8.3%	3.1%

* One livestock unit is defined as the equivalent of a mature cow of 250 kg in weight, where one camel = 1.25 livestock unit, one cow = 1.00 livestock unit, one goat = 0.15 livestock unit, and one sheep = 0.20 livestock unit (Brown, 1954; United States Department of Agriculture (USDA), 1976; Le Houerou and Hoste, 1977). The smallstock conversions are based on the equivalent of goats, since goats were more than three-quarters of the 1975 and 1982 smallstock populations.

Source: The 1975 figures are unpublished data obtained in 1984 from the Central Statistical Department, Ministry of National Planning, Mogadishu. The 1982 figures are quoted from the HTS (Vol. 1, 1982: 89).

The annual increase of animal types vary, with the populations of smallstock, cattle and camels estimated to have grown respectively by about 8, 6, and less than one per cent per year (Table 4.1). The apparent increase in the numbers of smallstock and cattle, compared to the incease in the camel population, raises the question as to whether there is a shift in herd structure from reliance on camels to cattle and small stock. This trend will be examined in the study of herd structure (Section 4.2). Nevertheless, the marked increase in the cattle and smallstock populations shows a trend towards a less widespread movement of pastoral groups. The fact is that cattle and smallstock need a greater number of watering points than camels, and, in addition these should have a greater degree of reliability. For example, it was reported during the Jilaal survey of the 1984 field work, that cattle must be watered every second day, and smallstock every three days, whilst camels often need water only once weekly. Cattle and smallstock are then more restricted to watering points than camels throughout the year, and consequently do not have the same geographic range of movement. This, clearly, has implications in terms of reducing both the number and geographic spread of pastoral movements in the region.

4.1.2 Livestock Ownership

Livestock in Bay region is typically raised by individual families, as more than 90 per cent of pastoral households own and manage their herds and flocks by themselves (Table 4.2). The pastoral household, therefore, is considered to be the basic management unit of livestock raising in Bay region. This system, however, maintains each individual household as an independent production unit and this implies freedom of control over many management aspects such as herd sizes, sales and slaughtering, all of which can have negative consequences for rangeland management in general. Consequently, pastoral households tend to maximise herd sizes without necessarily giving due consideration to the condition of rangelands.

Table 4.2 <u>The proportion of stock owned by pastoral households in Bay region, 1984</u>.

Proportion of stock owned	Camels No.	Camels %	Cattle No.	Cattle %	Smallstock No.	Smallstock %
None	1	0.7	2	1.0	1	1.0
>1/4	1	0.7	1	0.5	2	2.0
1/4-1/2	2	1.4	3	1.4	0	0.0
1/2-3/4	6	4.3	5	2.4	1	1.0
3/4-all	0	0.0	1	0.5	0	0.0
all	129	92.9	196	94.2	96	96.0
	139	100.0	208	100.0	100	100.0

Number and percentage of households owning

The total number of surveyed households: 240.

The total number of surveyed households owning livestock: 237.

Source: Compiled from the 1984 questionnaire survey.

The pattern of livestock ownership can vary according to the size of family. Table 4.3 shows a clear tendency for the average size of livestock units to increase with larger families. This does not imply only that the size of families and herds develop along parallel trends, but also reflects the greater availability of manpower among the bigger households to look after larger numbers of livestock. Thus, the availability of manpower in a household sets a limit on the number of livestock that is kept.

Table 4.3 Relationship between family size and the average herd size of camels, cattle, smallstock and livestock units in Bay region, 1984.

Family size (persons per household)	Camels	Cattle	Small-stock	Livestock units
	Average herd/flock size			
1 - 4	6	13	4	21
5 - 8	10	13	8	26
9 - 12	13	24	16	42
13 +	14	23	16	43

Source: Compiled from the 1984 questionnaire survey.

The pattern of livestock ownership does not only vary in number according to the family size, but also in type according to the labour composition in a household. Animal grazing is based on various types of household labour. Children of about 6 years of age to early teens are allowed to graze smallstock, older children, who are in their teens, are delegated the job of cattle grazing, and young men are assigned to graze camels (Behnke and Kerven, 1984). Clearly, therefore, the stage of family development and its age structure will be an influence on relative herd compositions. Table 4.3 shows that the average size of smallstock herds increases proportionately more according to family size, but this does not apply to the same extent to cattle and camel herds, as differences in their sizes between the smaller and the larger households is not as pronounced. This can be explained by the fact that the majority of members of the larger households are children who usually graze smallstock. Changes in herd compositions of livestock are carried out by exchanging and selling animals in response to the changing structure of household labour, as the mean age of the household members increases.

4.2 Herd Structure and Size

4.2.1 Herd Structure

The most numerous grazing animals in Bay region (as in all Somalia), are one-humped camels (*Camelus dromedarius*), hump-backed cattle (*Bos taurus*), abyssinian goats (*Capra walie*) and black-headed sheep (*Ovis aries*) (Hunt, 1951; Lewis, 1969a; HTS, Vol. 1, 1982). Despite the dominance of cattle in the economy, pastoral people, nevertheless, expend much energy in trying to raise various types of livestock. Table 4.4 shows that a substantial percentage (62.9 per cent) of the pastoral households keep two and more types of livestock, while only 37.1 per cent of those households keep only one single type of livestock. Likewise, HTS (Vol. 1, 1982) reported that about 70 per cent of livestock owners in Bay region have more than one type of livestock.

Table 4.4 Species Structure of livestock ownership in Bay region, 1984.

Type of livestock	No. of households	%
Camels only	14	5.9
Cattle only	73	30.8
Smallstock only	1	0.4
Camels and cattle	50	21.1
Camels and smallstock	14	5.9
Cattle and smallstock	24	10.1
Camels, cattle & smallstock	61	25.8
	237	100.0

Source: Compiled from the 1984 questionnaire survey.

Pastoral groups maintain a mixture of animal type in order to take advantage of the availibility of different plant species, in terms of feeding habits, drought resistance and economy uses. Camels normally provide milk throughout the year, and have the highest market prices. A mature camel was in 1984 sold for approximately 10,000 Somali shillings as an average. They can also easily be exchanged for other types of livestock. In addition, they are the most resistant livestock type to drought threats, as well as being beasts of burden. Cattle supply milk which can be made into ghee for nutritive and economic purposes. They have a good market value especially if sold for meat for approximately 5,000 Somali shillings per bull. Cattle are often slaughtered on special occasions, such as wedding feasts, while their skins are used as carpets. Smallstock produce milk which can be made into ghee as well, and a small cash return when sold. They are often slaughtered for smaller occasions like giving hospitality to guests. The exploitation of different plant species thus, constitutes a rational strategy for balancing the objectives of subsistence needs, drought security and cash income (Jamal, 1983).

Herd structures in Bay region, however, have been changing, with a clear shift on the part of livestock ownership from a reliance on camels and smallstock to a reliance on cattle, as the main livestock component (Table 4.5). The ratio of camels to cattle in 1952 was 276:100, but had declined to 122:100 in 1975. In the early 1980s, this ratio had altered further, dropping to 70 - 87 camels:100 cattle. Similarly, the ratio of smallstock to cattle was, in 1952, 596:100, being reduced to only 60 smallstock:100 cattle in 1984. Such a shift has also been reported in other parts of Somalia, especially in the northern regions (ILO/JASPA, 1977), and elsewhere in Africa and Asia, as in the Butana region of northern Sudan, where nomadic groups have managed to keep larger numbers of cattle and to dispose slowly of their camel herds (ILO, 1965). However, this shift not only shows a tendency towards a more settled way of life, but it also involves a greater rate of animal losses during the prolonged drought periods, as cattle are less resistant to drought threats compared to camels or goats. Some questions now arise as to how this change came about. Is it the result of increased water supplies (waro and wells)? Is it the result of improved veterinary services? Is it the result of increased market opportunities? These questions will be answered in Part Three of this study.

Table 4.5 Changing species structure of livestock in Bay region.

Year	Camels:Cattle ratio	Smallstock:Cattle ratio	Camels:smallstock ratio
1952*	276:100	596:100	46:100
1975	122:100	96:100	126:100
1982	87:100	105:100	82:100
1984	70:100	60:100	110:100

* The 1952 ratios are calculated from the livestock numbers of Upper Juba province which was in 1969 divided into three regions: Bay (the study area), Gedo and Bakool.

Source: These ratios are respectively derived from Lockwood Survey Corporation (LSC) (Vol. IV, 1968); Unpublished data obtained in 1984 from the Central Statistical Department, Ministry of National Planning, Mogadishu; HTS (Vol. 1, 1982); The 1984 questionnaire survey.

4.2.2 Herd Size

Herd sizes in Bay region range from one or two head to more than one hundred (Table 4.6), with an average of 11 camels, 17 cattle, and 10 smallstock per pastoral household. This converted into livestock units, amounts to a herd of 32 cattle-equivalents per household. This equivalent is very similar to total livestock units for Somalia as a whole which is 33 per pastoral household (Jamal, 1983).

Table 4.6 Holding herd size by livestock types in Bay region, 1984.

	Number and percentage of households owning					
Herd size	Camels		Cattle		Smallstock	
	No.	%	No.	%	No.	%
1 - 5	42	30.2	42	20.2	15	15.0
6 - 10	33	23.7	56	20.9	21	21.0
11 - 20	33	23.7	59	28.4	20	20.0
21 - 30	10	7.2	21	10.1	21	21.0
31 - 40	6	4.3	10	4.8	9	9.0
41 - 50	6	4.3	10	4.8	6	6.0
51 -100	7	5.1	8	3.8	7	7.0
101 +	2	1.5	2	1.0	1	1.0
	139	100.0	208	100.0	100	100.0

Source: Compiled from the 1984 questionnaire survey.

Table 4.6 shows that camel and cattle herds are mostly kept in smaller groups compared to smallstock, with about 75 per cent of camel and cattle owners have below 21 head of camels and cattle, whilst about 75 per cent of smallstock owners have less than 31 head of goats and sheep. Hunting Technical Services (Vol. 1, 1982) produced similar results by indicating, for example, that about 75 per cent of goats are maintained in groups of less than 31 head and about 50 per cent of cattle are kept in sizes of 20 head and below. This suggests that a herd of 1-20 camels or cattle, and 1-30 head of smallstock is the minimum size of livestock to maintain a pastoral household at a subsistence level. This is related to cattle owners rather than to camel or small stock owners, since more than four-fifths of pastoral households have cattle alone or cattle in some other combination (see Table 4.4). This also applies to agro-pastoral groups since more than 90 per cent of the sample are agro-pastoralists, who typically keep fewer stock, mainly cattle, as their subsistence needs are partially met from livestock products, the rest being met from crop production. Thus, the pastoral people of Bay region generally keep smaller numbers of livestock than in the central regions of Somalia (Jamal, 1983), since more than one-half of Bay region's population are agro-pastoralists.

4.3 Livestock Movement and Distribution

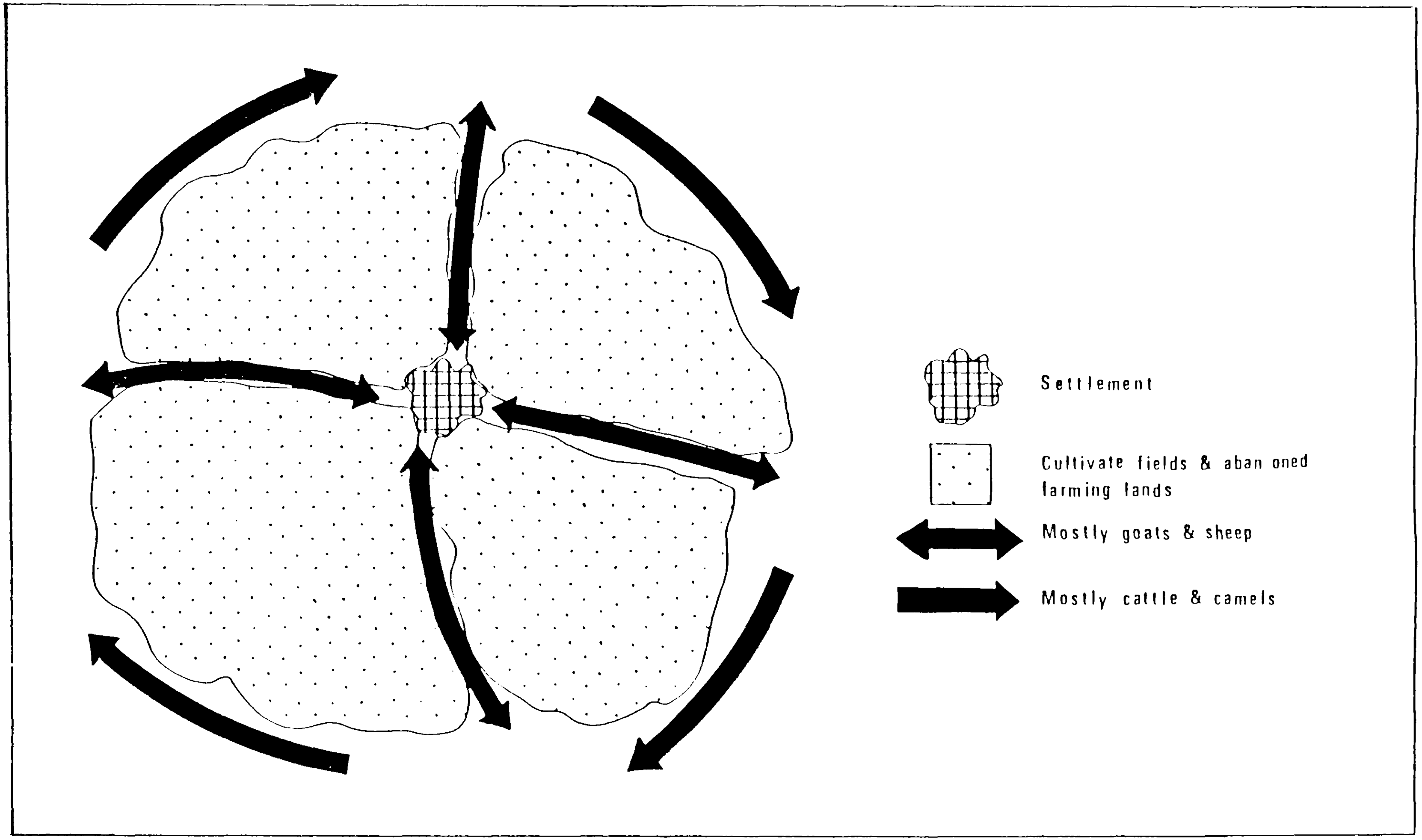
4.3.1 Livestock Movement

The underlying need to provide livestock with adequate forage and water, which vary from place to place and from one season to another in Bay region, makes it necessary for livestock to be moved in order to meet this need. Livestock movements are generally unpredictable at the micro-scale and, as such, it is extremely difficult to make a full assessment of directions followed and distances moved. Nevertheless, these movements have been discussed by HTS

(Vol. 1, 1982), Behnke and Kerven (1984) and University of Wyoming (Vol. 2, 1984). However, according to the information collected during the 1984 field work and according to the above studies, livestock movements can be divided into two main forms: short movements and long movements.

Short movements are characterized by livestock being moved up to 30 kms into the grazing areas around the settlement, including previously cultivated and abandoned fields and currently cultivated harvested fields. These movements are divided into two types: radial and circular (Figure 4.1). The radial pattern mostly involves smallstock, with a diurnal movement between the settlement and the surrounding grazing areas. The circular pattern often constitutes cattle and camels in a continuous movement around the settlement. However, these two patterns are mostly practised by households with smaller numbers of livestock. Short movements are more common in Bay region at the present time, since most of the pastoral households keep smaller numbers of livestock. Thus, this form of movement is not complicated, but may be influenced by the incidence of tick infestations. Pastoral households avoid areas immediately surrounding the settlement infested by ticks, or otherwise it is necessary to build smudge fires in order to reduce the effect of tick-borne diseases on their animals. Nevertheless, these radial movements display a negative consequence by exposing marginal areas surrounding the settlements to overgrazing. The fact is that grazing pressures on these margins are more severe owing to the spatial concentration of livestock movements throughout the year. Contrary to this, however, is the fact that short livestock movements have an important positive consequence,

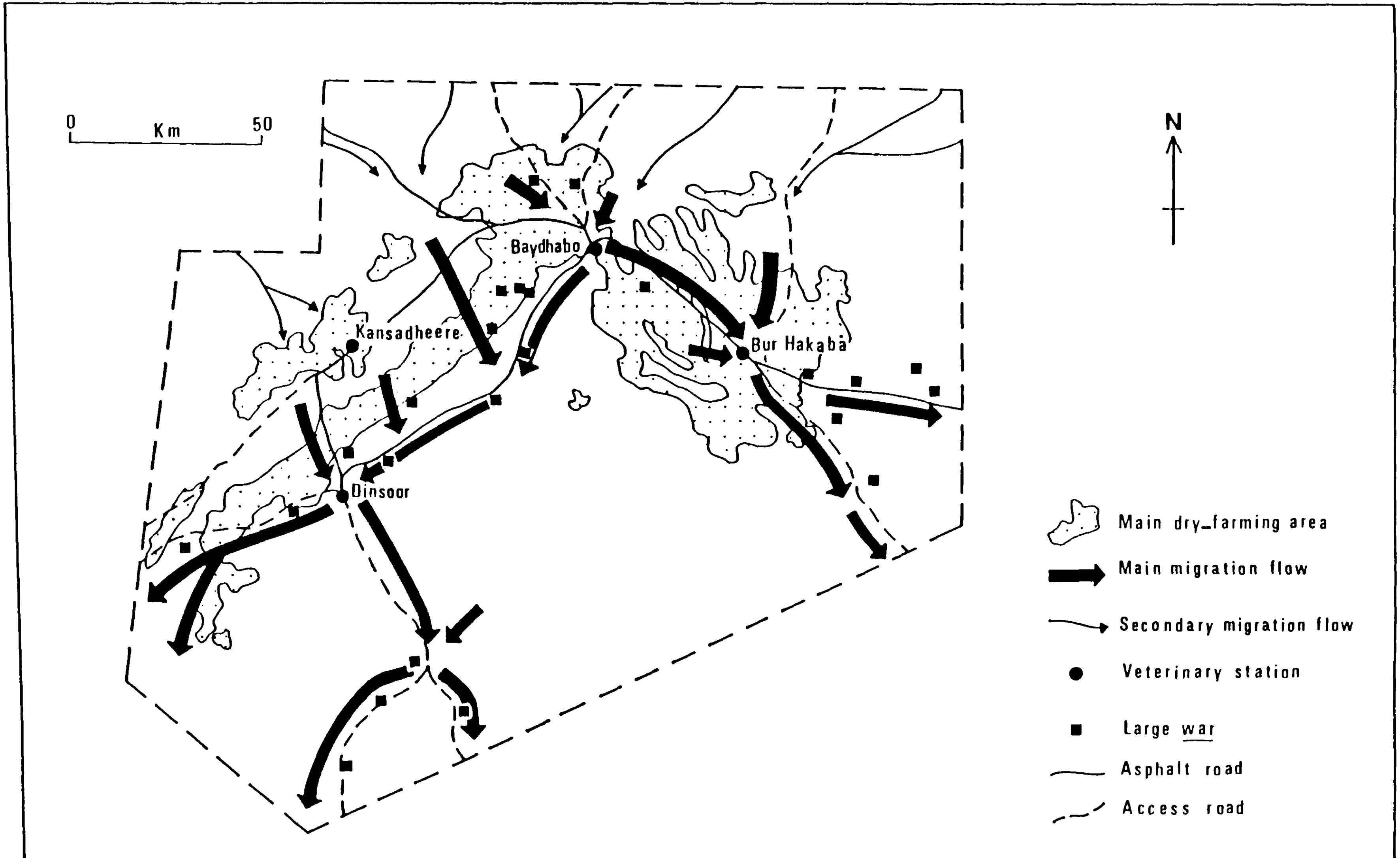
Figure 4.1: Stylised radial and circular patterns of livestock movements in Bay region.



as animals are grazed in areas often not far from the settlements, and, as such, the pastoral household can be assured of a milk supply throughout the year.

Long movements mostly involve camel and cattle herds, frequently moved up to 200 kms in a southward direction during the dry seasons, and back northwards through Bay region's rangelands in the return trek during the rainy seasons. These movements are highly complex since they involve not only people, but also mixed livestock herds of both Bay and its neighbouring regions, particularly Gedo, Bakool and Hiran regions to the north-west, north and north-east. Herds from these regions either remain in Bay region or are destined for the riverine areas, depending on the status of forage and water supplies in the study area. The main routes of the southern trek during the dry seasons are closely associated with the geographic distribution of main dry-farming areas around Baydhabo, Kansadheere, Dinsoor and Bur Hakaba, the main livestock markets and veterinary stations of Baydhabo, Dinsoor, Kansadheere and Bur Hakaba, and the large <u>waro</u> on the roads of Baydhabo-Dinsoor, Baydhabo-Bur Hakaba and Dinsoor-Yak Brawa (Figure 4.2). This movement enables the herds of both Bay and neighbouring regions to survive during the year, by making comprehensive use of available water and forage resources of Bay region and the riverine areas to the south. Nevertheless, this movement cannot be undertaken without milch camels which are crucial to the survival of the herders during the journey. Furthermore, cash can be obtained directly from milk sales or, to a lesser extent, milk itself can be used in exchange for the right of access to watering points and crop residues for grazing. However, long livestock movements can have negative consequences. Firstly, extra grazing pressures

Figure 4.2: Long-distance movements of livestock towards the southern areas during the dry seasons.

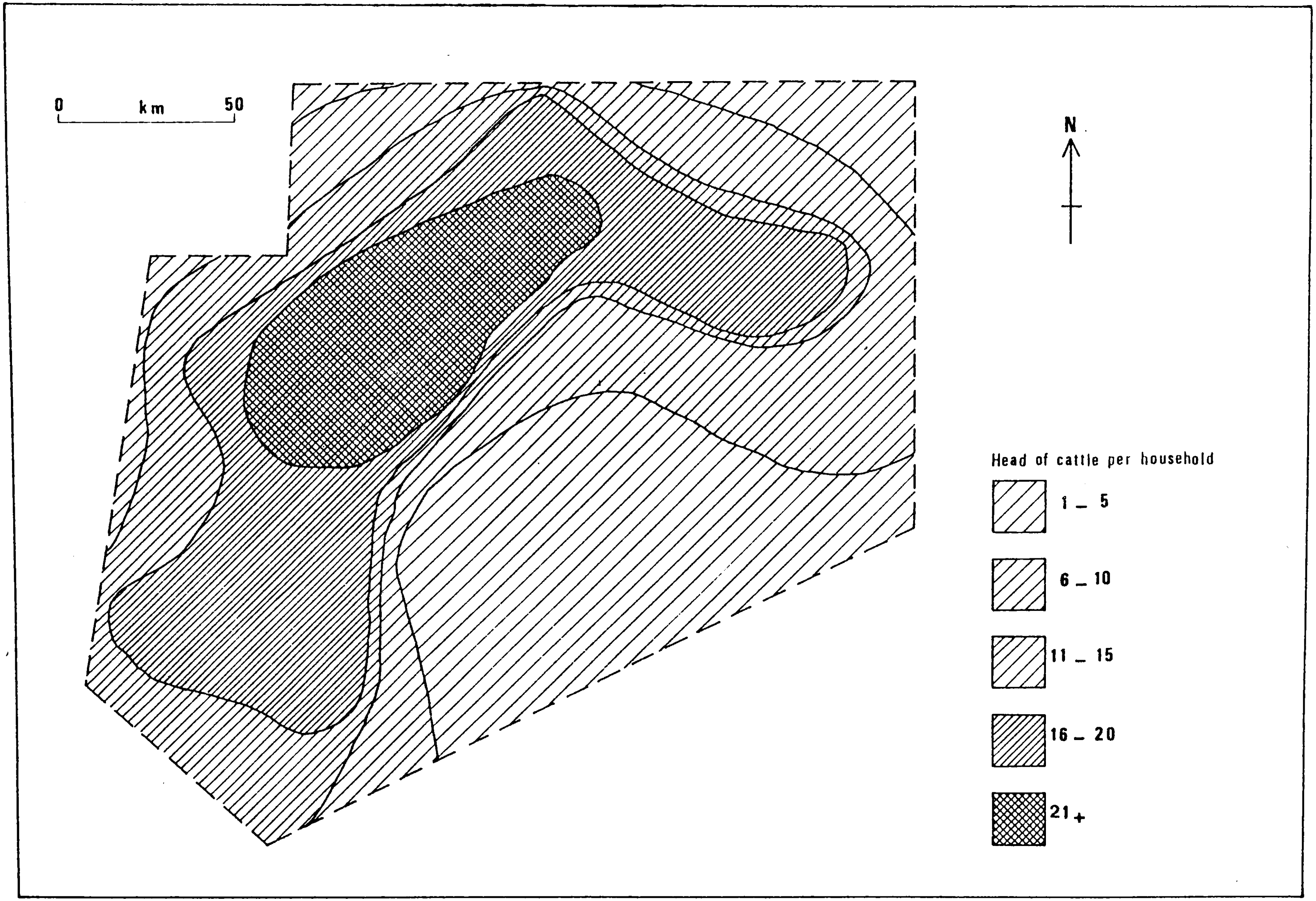


by the herds from the neighbouring regions are exerted on the rangelands of Bay region, especially around the reliable watering areas where herds are more likely to gather. Secondly, pastoral households generally have less access to milk supplies during the dry seasons, since most milch camels are driven south, while only a few transport camels and milch cattle, as well as smallstock, are left at the homestead. Finally, the combined effects of the physical demands of the southern trek and the dry seasons lead to a further decline in the productivity of livestock especially when there are insufficient supplies of forage and water during the journey. It was reported in the Jilaal (dry) season, during the 1984 field work, that many households lost at least some of their cattle due to the lack of forage rather than water; in addition, other animals, with little resistance to infection, suffered the same fate. Both short and long livestock movements are affected not only by the availability of range forage and drinking water supplies, but also by the availability of crop residues, the threat of biting insects, the production of milk to be consumed or sold, and the availability of household labour.

4.3.2 Livestock Distribution

The distribution of different types of livestock in Bay region varies from area to area. The distribution of cattle generally decreases from the north-west to the south-east (Figure 4.3). This distribution is clearly associated with the agro-pastoral settlements around Baydhabo, Kansadheere, and to a lesser extent, around Dinsoor and Bur Hakaba. These settlements are not only adjacent to the main market and veterinary centres, but also include a high proportion of wells and waro which supply water throughout the year.

Figure 4.3: The general distribution of cattle in Bay region.



In addition, crop residues are also readily available, as part of the diet of cattle herds for part of the year, as well as grasses, herbs and fallen leaves being available in the surrounding range areas. Quite oppositely the distribution of camels generally becomes less dense from the south-east to the north-west (Figure 4.4). Thus, the highest density camel herds are mostly found in the central and southern areas of Bay region. These areas are covered with shrub/bush vegetation, suitable for the raising of camels rather than cattle. The distribution of smallstock (Figure 4.5) is relatively similar to that of cattle and, as such, the highest density of smallstock is found in the main dry-farming lands around Baydhabo and Kansadheere. The distribution of livestock in Bay region reflects the distribution of environmental resources, especially forage and water supplies, which are in turn affected by the distribution of rainfall, and the distribution of pastoral people and their economic activities.

4.4 Livestock Sales and Slaughter

4.1.1 Livestock Sales

The sale of livestock is prevalent among the pastoral people of Bay region in order to meet specific cash expenses. Table 4.7 shows that camels are sold, but not as often as cattle or smallstock. This suggests that pastoral households prefer to sell cattle or smallstock rather than camels. The fact is that camels are only sold at times of greatest need for cash such as the payment of bride-price or to meet expenditure on making a pilgrimage to Mecca. Cattle are also sold at times of greatest need, but as cattle prices are only half those for camels (see Section 4.2), this indicates that more

Figure 4.4: The general distribution of camels in Bay region.

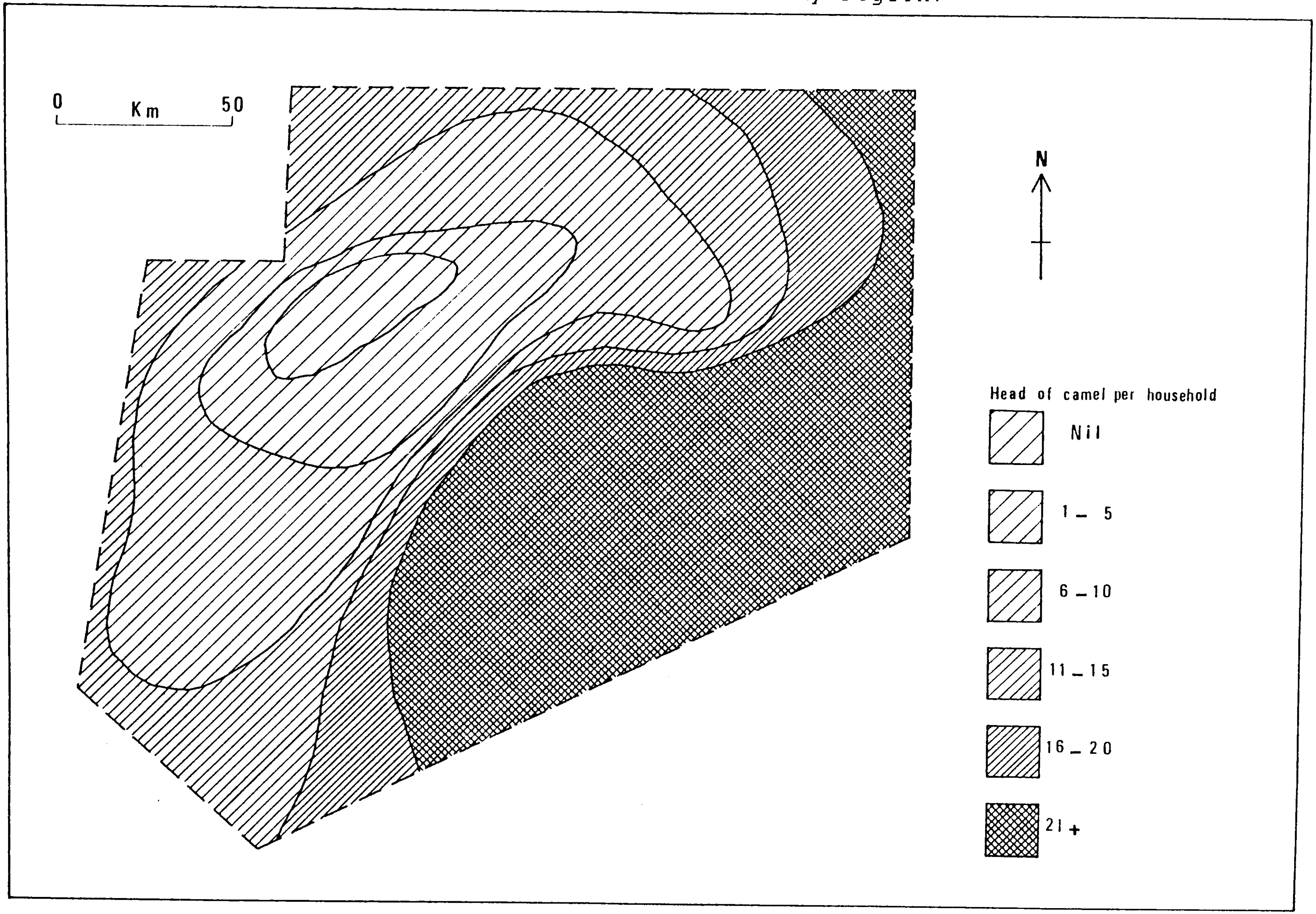
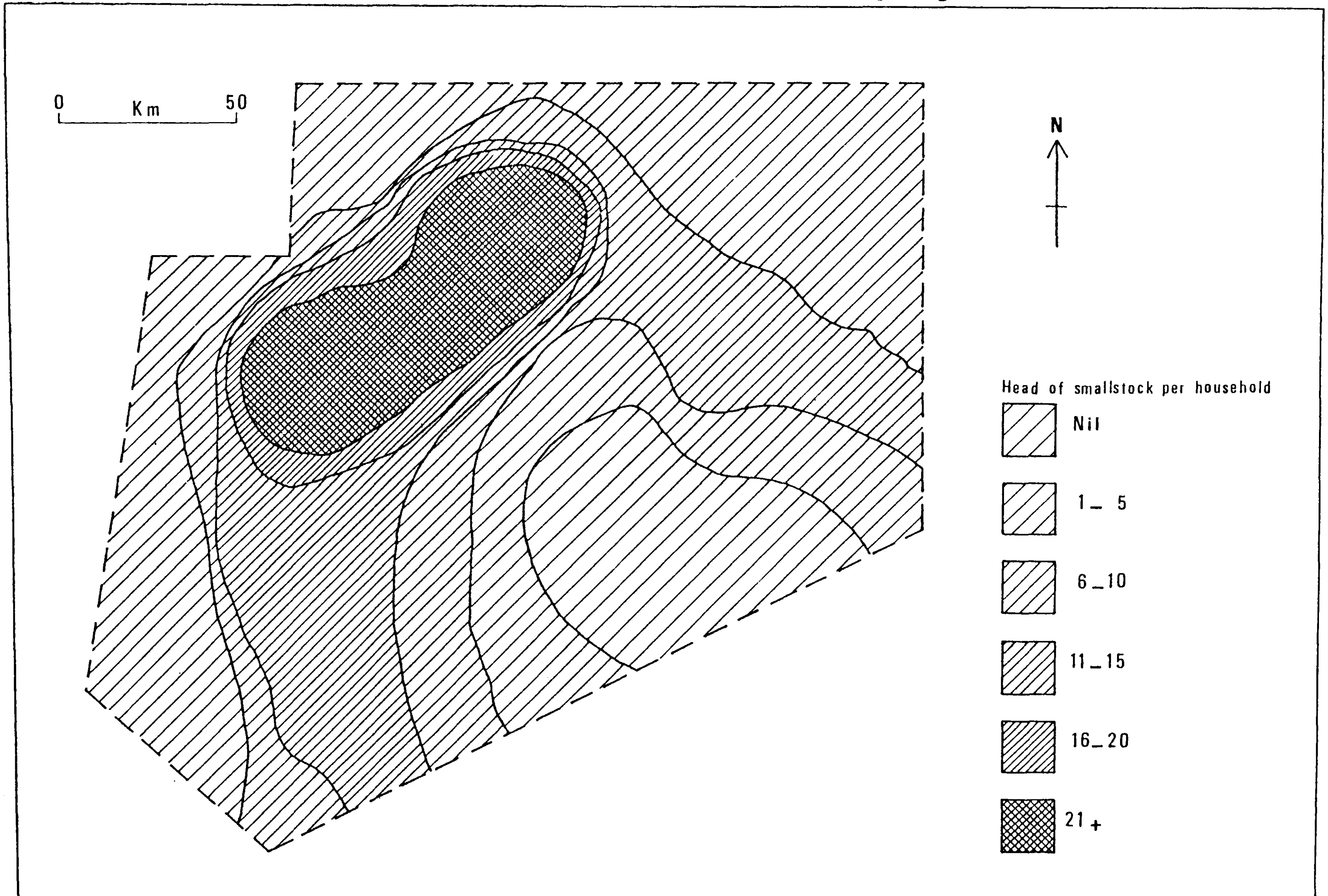


Figure 4.5: The general distribution of smallstock in Bay region.



cattle are required to be sold in order to cover intended expenses. In this case, the number of cattle sold is greater than the number of camels, reflecting the generally larger size of cattle herds and the greater number of stock owners keeping cattle. Smallstock are sold more frequently in order to cover minor costs such as household needs for clothes, tea and sugar. The price of smallstock is much less than the price of cattle which is in the ratio of about one to eight. This is usually enough to sustain household needs, along with another source of income like the sale of milk surpluses. Clearly, the type of stock sold is matched to cover the expenses that are required, but this only takes place among pastoral households who own two or more types of livestock (Behnke and Karven, 1984). Nevertheless, the proportion of stock sold is mostly less than one-quarter of the herd or flock (Table 4.7). This indicates that pastoral households sell the minimum number necessary so as to maintain and increase herd size. This is another indication of the long-term accumulation of livestock in Bay region.

Table 4.7 The proportion of stock sold during the year by pastoral households in Bay region, 1984.

Proportion of stock sold	Number and percentage of households owning					
	Camels		Cattle		Smallstock	
	No.	%	No.	%	No.	%
None	55	39.6	58	27.9	22	22.0
>1/4	79	56.8	134	64.4	50	50.0
1/4 - 1/2	3	2.2	14	6.7	25	25.0
1/2 - 3/4	2	1.4	2	1.0	3	3.0
3/4 - all	0	0.0	0	0.0	0	0.0
all	0	0.0	0	0.0	0	0.0
	139	100.0	208	100.0	100	100.0

Source: Compiled from the 1984 questionnaire survey.

The sale of livestock mostly involves male animals. Table 4.8 shows that the sale of males alone or males with females accounts for the highest proportion of sales amongst the three types of livestock. This makes good sense for two reasons: by retaining female stock, more milk becomes available for household consumption and more stock is made available for reproduction. Significantly, the sale of female animals is usually of old females with reduced chances of reproduction or those with impaired teats. In addition, pastoral households are often forced to sell female stock owing to the unavailability of male animals. The pastoral people of Bay region are then similar Somali pastoralists in general, in selling mainly male animals surplus to requirements for livestock production and reproduction, rather than keeping them as insurance against future emergencies (Swift, 1979).

Table 4.8 The sex type of stock sold by pastoral households in Bay region, 1984.

	Number and percentage of households selling					
Sex type	Camels		Cattle		Smallstock	
	No.	%	No.	%	No.	%
Male only	57	67.9	98	65.3	51	65.4
Female only	1	1.2	1	0.7	1	1.3
Male & female	26	30.9	51	34.0	26	33.3
	84	100.0	150	100.0	78	100.0

Source: Compiled from the 1984 questionnaire survey.

The sale of livestock is mostly carried out during the Jilaal (dry) season, with between about 50 and 80 per cent of the pastoral households selling their animals during this time (Table 4.9). This is done, firstly, in order to reduce animal loss which is generally higher in the hard dry season of Jilaal; secondly, to pay for farming tools such as hoes, which are necessary for the following Gu (wet) season, as this is the main cropping period; and thirdly, more importantly, to buy sorghum when the household stores of grain are mostly consumed. Table 4.9 shows that most of the animal sales took place in the middle of Jilaal (dry) season, when most of the available range forage and drinking water have been consumed. This suggests that pastoral households are less concerned about rangeland ecosystems than they are about their animals, especially as the rangelands are communally used, while the livestock are individually owned and raised. This attitude, however, has an effect on the condition of pastureland in terms of the long-term deterioration of rangeland ecosystems.

Table 4.9 The main time of stock sales by pastoral households in Bay region, 1984.

	Number and percentage of households selling					
Time	Camels		Cattle		Smallstock	
	No.	%	No.	%	No.	%
Gu season	5	6.0	16	10.7	9	11.5
Hagai "	2	2.4	7	4.7	5	6.4
Dayr "	2	2.4	6	4.0	6	7.7
early Jilaal	18	21.4	24	16.0	17	21.8
mid- Jilaal	48	57.1	81	54.0	33	42.3
end Jilaal	9	10.7	16	10.6	8	10.3
	84	100.0	150	100.0	78	100.0

Source: Compiled from the 1984 questionnaire survey.

4.4.2 Livestock Slaughter

The slaughter of livestock is uncommon among the pastoral peoples of Bay region, and generally takes places only for a very limited number of reasons (Table 4.10). The majority of pastoral households slaughter some of their own animals on special occasions such as a wedding feast (dubaa), the commemoration of the prophet Mohamed's birthday (mowluud) and the first day of pilgrimage (arafat). Smallstock and, to a lesser degree, cattle are preferred to camels for slaughter on such occasions, because the former, particularly smallstock, is of a lower economic value than the latter. The pastoral people will also slaughter their own stock when they are in danger of dying; around 40 per cent of livestock owners slaughter their own animals in such cases. Only the skin of the animal is used while its meat is discarded. Although a relatively large number of households slaughter livestock at some time during the year, only a negligible proportion of stock owners slaughter their own animals monthly or yearly and none slaughter weekly. This indicates that pastoral people of Bay region and, indeed, most Somali pastoralists, are not large consumers of meat, as are their neighbours, the Maasai pastoralists of Kenya and Tanzania (Mares, 1965). The fact is that milk and sorghum constitute the bulk of the diet for most pastoral people in Bay region.

Table 4.10 <u>Slaughter of livestock by pastoral households in Bay region, 1984</u>.

Freqencies	Number & percentage of households slaughtering					
	Camels		Cattle		Smallstock	
	No.	%	No.	%	No.	%
Never	20	14.0	13	6.0	2	2.0
Special occasions	93	67.0	179	86.0	91	91.0
Dying animals	59	42.0	90	43.0	39	39.0
Annually	2	1.0	2	1.0	2	2.0
Monthly	0	0.0	0	0.0	3	3.0
Weekly	0	0.0	0	0.0	0	0.0

The total number of surveyed households owning camels: 139.
" " " " " " " cattle: 208.
" " " " " " " smallstock: 100.

NB households may give more than one answer.

Source: Compiled from the 1984 questionnaire survey.

The great majority of livestock slaughtered in Bay region by pastoral households is male (Table 4.11). In this case, the pastoral strategy of keeping male animals as an insurance against future disasters appears not to be very compelling.

Table 4.11 The sex type of livestock slaughtered by pastoral households in Bay region, 1984.

Sex type	Number & percentage of households slaughtering					
	Camels		Cattle		Smallstock	
	No.	%	No.	%	No.	%
Male	95	100.0	181	100.0	96	100.0
Female	12	13.0	30	16.0	32	33.0

The total number of households slaughtered camels: 95.
" " " " " " cattle: 181.
" " " " " " smallstock: 96.
NB households may give more than one answer.

Source: Compiled from the 1984 questionnaire survey.

4.5 Livestock Problems

Pastoral people in Bay region are well aware of the problems which affect their animals, and these mostly include enzootic animal diseases and parasites, as well as periodic shortages of forage, lack of water and shortage of labour. Apart from rinderpest and black-quarter that affect cattle only, there are a number of other diseases which affect all three types of livestock in Bay region (Tables 4.12, 4.13 and 4.14).

Tick-borne diseases are the most serious problem, producing a points-score of more than 90 per cent for all three species of livestock, with the vast majority of farmers, in all three cases, considering it to be a very serious

Table 4.12 Problems for camels in Bay region, 1984.

Problems	Very serious		Serious		Neutral		Not serious		Not serious at all		Total points score	Score as % of max.
	No	%	No	%	No	%	No	%	No	%		
1. Tick-borne diseases	116	83.4	13	9.3	-	-	3	2.2	7	5.1	506	91.0
2. Trypanosomiasis	78	56.1	27	19.4	1	0.7	14	10.1	19	13.9	409	73.6
3. Animal diarrhoea	67	48.2	26	18.7	2	1.5	12	8.6	32	23.0	362	65.1
4. Anthrax	56	40.3	33	23.7	4	2.9	15	10.8	31	22.3	346	62.2
5. Lack of fodder	43	30.9	23	16.5	4	2.9	14	10.1	55	39.6	263	47.3
6. Helminthiases	40	28.8	21	15.1	5	3.6	11	7.9	62	44.6	244	43.9
7. Lack of water	31	22.3	28	20.1	5	3.6	14	10.1	61	43.9	232	41.7
8. Haemorrhagic septicaemia	36	25.9	18	13.0	-	-	12	8.6	73	52.3	210	37.8
9. Shortage of labour	8	5.7	40	28.8	7	5.1	22	15.8	62	44.6	188	33.8
10. Foot & mouth disease	8	5.7	6	4.3	2	1.5	10	7.2	113	81.3	64	11.5

The total number of surveyed households owning camels: 139.
Maximum score for any one problem: 556.
Source: Compiled from the 1984 questionnaire survey.

Table 4.13 Problems for cattle in Bay region, 1984.

Problems	Very serious		Serious		Neutral		Not serious		Not serious at all		Total points score	score as % of max.
	No	%	No	%	No	%	No	%	No	%		
1. Tick-borne diseases	174	83.6	17	8.2	1	0.5	10	4.8	6	2.9	759	91.2
2. Foot & mouth disease	107	51.4	50	24.1	9	4.5	20	9.6	22	10.6	616	74.0
3. Animal diarrhoea	113	54.3	36	17.3	7	3.4	16	7.7	36	17.3	590	70.0
4. Black-quarter	101	48.6	40	19.3	15	7.2	25	12.0	27	13.0	579	69.0
5. Helminthiases	97	46.6	45	21.6	2	1.0	15	7.5	49	23.6	542	65.1
6. Lack of fodder	119	57.2	13	6.3	3	1.4	7	3.4	66	31.7	522	62.7
7. Lack of water	115	55.3	10	4.8	-	-	5	2.4	78	37.3	495	59.5
8. Anthrax	58	27.9	45	21.6	13	6.3	26	12.5	66	31.7	419	50.9
9. Bovine pleuropneumonia	76	36.2	26	12.5	8	3.8	12	5.8	86	41.4	410	49.3
10. Rinderpest	64	30.4	13	6.2	16	7.7	24	11.5	91	43.8	351	42.2
11. Haemorrhagic septicaemia	63	30.3	23	11.1	5	2.4	9	4.3	108	51.8	340	40.9
12. Trypanosomiasis	53	25.5	13	6.2	12	5.8	20	9.6	110	52.9	295	35.5
13. Shortage of labour	50	24.0	12	5.8	11	3.5	20	9.6	55	55.3	278	33.4

The total number of surveyed households owning cattle: 208.
Maximum score for any one problem: 832.
Source: Compiled from the 1984 questionnaire survey.

problem. This score does not only imply that tick-borne diseases are a widespread problem over most rangelands of Bay region, but also methods like smudge fires, that are used to reduce the effect of these diseases on the infected animals, are generally ineffective. The use of smudge fires is not only the easiest way for the pastoral households to treat tick-borne diseases, but is also necessary owing to the shortage of drugs, like Acaprin, in the veterinary stations and mobile dispensaries in Bay region. The problem of tick-borne diseases becomes more severe during the wet seasons when animals are usually grazed inside the rangelands. At these times, the availability of drugs in those centres becomes much reduced for cattle herders.

Animal diarrhoea is also a common problem among the livestock of Bay region. The change in animal diet from one season to another, owing to the seasonal variations in the supply of range forage, is the main explanation for the spread of animal diarrhoea, as such changes cause digestive upsets for the grazing animals.

Trypanosomiasis is only common among camel herds, as tsetse flies, which transmit this disease, generally do not occur in Bay region. The infestations of tsetse-fly in Somalia are only found in the riverine areas to the south of Bay region. As such, the camel movements during the dry seasons to the riverine areas, explain the spread of trypanosomiasis among camels.

Foot and mouth disease, black-quarter, helminthiases, lack of forage, lack of drinking water, anthrax and bovine pleuro-pneumonia are important problems for livestock,

Table 4.14 Problems for smallstock in Bay region, 1984.

Problems	Very serious		Serious		Neutral		Not serious		Not serious at all		Total points score	Score as % of max.
	No	%	No	%	No	%	No	%	No	%		
1. Tick-borne diseases	90	90.0	4	4.0	-	-	1	1.0	5	5.0	373	93.3
2. Animal diarrhoea	41	41.0	17	17.0	7	7.0	2	2.0	33	33.0	231	57.8
3. Lack of fodder	43	43.0	13	13.0	2	2.0	6	6.0	36	36.0	221	55.3
4. Lack of water	28	28.0	26	26.0	3	3.0	6	6.0	37	37.0	202	50.5
5. Helminthiases	36	36.0	14	14.0	4	4.0	7	7.0	39	39.0	201	50.3
6. Anthrax	19	19.0	10	10.0	6	6.0	5	5.0	60	60.0	123	30.8
7. Haemorrhagic septicaemia	12	12.0	16	16.0	3	3.0	3	3.0	66	66.0	105	26.3
8. Trypanosomiasis	13	13.0	3	3.0	4	4.0	3	3.0	77	77.0	72	18.0
9. Shortage of labour	3	3.0	14	14.0	6	6.0	4	4.0	73	73.0	70	17.5
10. Foot & mouth disease	6	6.0	12	12.0	-	-	6	6.0	76	76.0	66	16.5
11. Caprine pleuropneumonia	5	5.0	10	10.0	2	2.0	7	7.0	76	76.0	61	15.3

The total number of surveyed households owning smallstock: 100.
Maximum score for any one problem: 400.
Source: Compiled from the 1984 questionnnaire survey.

particularly cattle, with points-scores between approximately 50 and 74 per cent. Rindepest, haemorrhagic speticaemia disease and labour shortages are reported as not being very serious problems.

4.6 Summary

Concern in this chapter has been with animal grazing as a form of land-use in Bay region. This form is practised by about 99 per cent of the pastoral households in the region, as 237 of the 240 surveyed samples keep livestock. The implication of this result is that livestock grazing is not only common among the local inhabitants, but also controlled by individual households. In this respect, herd management techniques are directly connected with animal grazing, rather than to the condition of the pasturelands. The reason is that pasturelands are owned communually, whereas livestock is privately owned. Such techniques involve, on average, a herd of 32 livestock units per household, in spite of the importance of cattle in the pastoral economy. Livestock sales generally account for less than one-quarter of the herd, these being carried out during the dry season of Jilaal. Livestock movements, on the other hand, involve two main types: short movements, which take place near the pastoral settlements; and long movements which go the riverine areas to the south of Bay region. However, these adopted practices tend to encourage the maintenance of larger herds of different species. With the main pastoral techniques of livestock grazing covered by this chapter, the following chapter discusses dry-farming as a second form of land-use activity in Bay region.

CHAPTER FIVE

DRY-FARMING

5.1 Dry-Farming Areas

The rangelands of Bay region are also used for crop production, but only on a very limited scale, ranging between 3 and 11 per cent of the total region's area. This is not only due to the amount of rainfall, and its distribution, but also to the distribution of Vertisols soil type that are mostly used for cultivation. The available data indicate that the area of dry-farming lands has been increasing in recent years. Landsat satellite images are one of the data sources for interpreting the percentage of change in land-use for crop production, although such change is difficult to detect accurately on these Landsat images because of poor resolution, particularly in the earlier images. A major step forward in remote sensing of the environment was taken by the National Aeronautics and Space Administration (NASA) on July 23, 1972 with the launching of the first Earth Resources Technology Satellite (ERTS-1), subsequently renamed Landsat-1 in 1975. Four more satellites in this series, were launched on Janauary, 1975 (Landsat-2), March, 1978 (Landsat-3), July, 1982 (Landsat-4) and on March 1, 1984 (Landsat-5).

The cost of Landsat images for Bay region as a whole was prohibitive. Therefore, an attempt was made to assess the geographic extent and patterns of change within a small part of the region, this being the north eastern quadrant around Bur Hakaba. The results within this small area may be extended to apply to the whole of Bay region, where not only similar environmental conditions apply, but also similar development policies are undertaken by the Somali government. However, only three images acquired by the the Landsat Multi-Spectral Scanner (MSS) were chosen to assess the percentage of change in the area of dry-farming lands around Bur Hakaba, these are: (1) MSS scene acquired by Landsat-1 on 26th January, 1973 with 10 per cent cloud cover, (2) MSS scene acquired by Landsat-3 on 26th December, 1978 with 10 per cent cloud cover, and (3) MSS scene acquired by Landsat-5 on 11th March, 1985 with zero per cent cloud cover.

The selection of these images was based on four criteria to simplify the application of Landsat images in such study. The first is that all these three images have been acquired by similar four-channel scanner (MSS) systems. These systems are one of the most sophisticated devices used in remote sensing from earth orbiting satellites. The solar radiation reflected from the earth's surface is sensed by these systems in four spectral bands. These are: band 4 (green), band 5 (red) and bands 6 and 7 (near infrared bands). These bands are renamed band 1, band 2, band 3 and band 4 respectively in Landsat-4 and-5. False colour image can be produced from the green, red and one of the infrared images, by printing the green image negative by a blue light, the red by a green light and the infrared by a red light (Lillesand and Kiefer, 1979). Secondly, a repetitive worldwide coverage of MSS imagery has been acquired since 1972. This allows the selection of images which were acquired over the same geographic area with long time intervals between them to assess the change in land-use over long periods. The images which were selected for this study can show the change in land-use over the two successive periods of 1973-1978 and 1978-1985. Thirdly, these Landsat images were all acquired in the same season of the Jilaal. Finally, these Landsat images were of good quality, with a minimum percentage of cloud cover ranging between zero and 10 per cent.

A major difficulty in interpreting the false colour Landsat MSS images is that each image has a different colour set asigned to the three spectral bands. The first MSS false colour image is printed using yellow light for band 4, red light for band 5 and blue light for band 6. The second false colour MSS image is printed using yellow, red and blue for bands 4, 5 and 7 respectively. The third false colour MSS image is printed using blue, green and red for bands 1,2, and 4 respectively. While the dry-farming land is shown with a combination of reddish and light yellowish tone in both the first and second MSS images, it is shown with light blue tone in the third. In addition to the colour assignment, the different tones with which dry-farming land is shown in these images is due to the fact that while both the first and second images were acquired at the begining of the dry season of Jilaal, the third image was acquired at the end of the dry season of Jilaal. Both the first and second images show dry-farming land as a reddish tone due to the fact that the ground moisture and crop residues which were present at that time are highly reflective to band 5 which was printed using red light. On the other hand, both the ground moisture and crop residues were not present at the time of acquisition of the third image and the light blue tone is a result of the bare dry-farming land. However, it has been quite possible, and reasonably straightforward, to interpret these images using a map of the dry-farming areas for Bay region published in 1982 by HTS (Vol. 1, 1982). The dry-farming area around Bur Hakaba which is shown on this map (see Figure 3.1) was identified on the three Landsat MSS images. Then all land surrounding this area, and appearing on the MSS images with the same colour tone as the area shown on the map and identified on the image, was interpreted as extentions or reductions to this dry-farming land. Using this technique the difficulty arising from the different colour assignments in the three Landsat images was solved.

The method of calculation of the area of dry-farming lands interpreted on the images was undertaken as follows. Firstly, the areas were delimited on the Landsat images and then traced onto tracing paper, and later transferred to graph paper. Secondly, the number of squares which each area represents was calculated and using the scale of Landsat MSS images (1:1000,000) the total area under cultivation was then calculated for 1973, 1978 and 1985 (Figure 5.1). The results of this area calculation show that 1275 square kilometres of dry-farming lands in 1973 as against 1500 square kilometres in 1978 and 1750 square kilometres in 1985 (Table 5.1), bringing the differences in cultivated area between these three years to 225 square kilometres between 1973 and 1978, 250 square kilometres between 1978 and 1985, and 475 square kilometres between 1973 and 1985. These figures represent an increase of 18 per cent (between 1973 and 1978), 17 per cent (between 1978 and 1985) and 37 per cent (between 1973 and 1985). The rate of increase in cultivated land is then about 3 per cent per year over the 12-year period from 1973-1985.

Figure 5.1: The estimated area of dry-farming lands around Bur Hakaba.

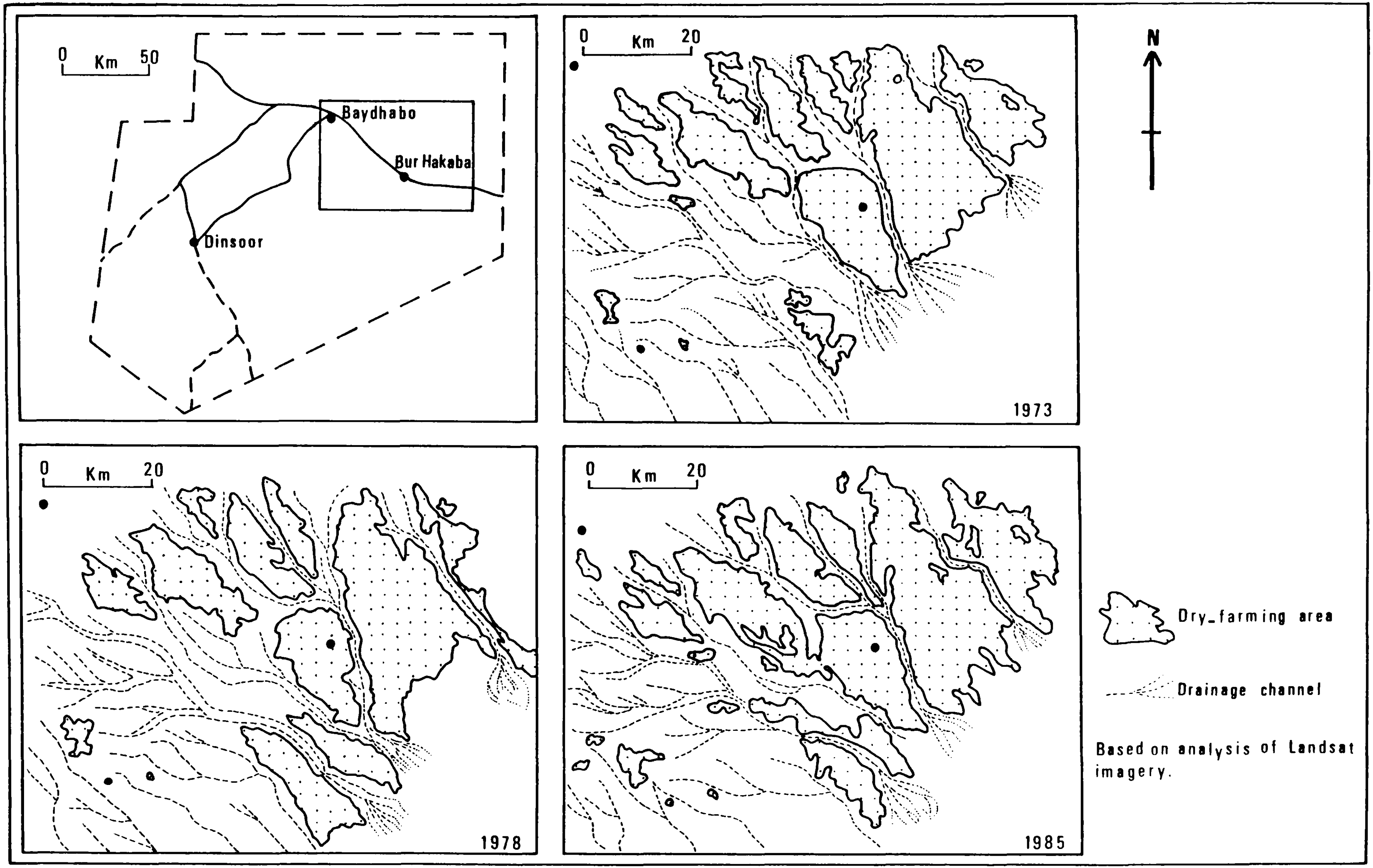


Table 5.1 The estimated area of dry-farming lands around Bur Hakaba.

Year	Area under cultivation
1973	1275 square kms.
1978	1500 " "
1985	1750 " "

Source: MSS Scene acquired by Landsat-1 on 26th January, 1973; MSS Scene acquired by Landsat-3 on 26th December, 1978; MSS Scene acquired by Landsat-5 on 11th March, 1985.

A technical report by HTS (Vol.2, 1982) is another source of data for interpreting the changes in land-use area for cultivation in Bay region. It reported that the area of dry-farming land had shown an increase of approximately 1.4 per cent per annum during the 9-year period from 1973-1982, which is hardly noticeable. There is, consequently, a contrast between the findings of the Hunting report and the present findings, although the periods are rather similar and the methods which were used in determining the increase of dry-farming area from Landsat images are similar too. However, there is a general increase in the areas under cultivation in the region. The annual growth in population and dry-farming land estimated in this study seem to develop along parallel lines, since the annual increase in the population was shown in Chapter Two to be 3 per cent as well. The extension of cultivated areas, which implies an increase in crop production, has become necessary to meet the needs of the increasing population for food. Le Houerou (1976) reached the same conclusion in areas like North Africa which bears some resemblance to the study area in terms of rangeland ecosystem and growth in population.

Nevertheless, further information needs to come to light about this general expansion of cultivated land. Some questions then arise: is it the result of abundant rainfall? Is it the result an accompaniment of changing herd structures? Is it the result of improved agricultural services? These questions will be discussed in Part Three of this study.

5.2 Crop Management Techniques

Information collected during the 1984 field work and the discussions of Hunting (HTS, Vol. 2, 1983) and University of Wyoming (Vol. 2, 1984) show rudimentary methods of crop husbandary are adopted, since the farming technology available to most agro-pastoral households extends little further than the short- or long-handled hoe (yaambo). This reflects the subsistence character of farming in the region. There are five important elements used in crop management in Bay region. Firstly, field preparation which only involves cutting out old stumps and weeds by using a short-handled yaambo, and collecting the debris into heaps and burning it in situ. Occasionally farm lands, especially those with depleted soils, are divided into a series of small square-shaped basins, no greater than 4 square metres. This system is locally known as kawaawi and its purpose is to maximize soil moisture by retaining as much rainwater as possible.

The second element is that of seeding which usually takes place after the first showers of the Gu and Dayr seasons, although some agro-pastoral households plant seed at the end of Jilaal and Hagai dry seasons if there is perceived to be a good chance of rainfall occuring at the beginning of growing seasons. Seeding holes are made in the top soil by using a long-handled yaambo (Plate 5.1) and a pinch of about 5 seeds is usually placed in each hole and covered with a thin layer of soil by the foot of the sower (Plate 5.2). Spacing between holes is irregular and this is associated with the simple way of seeding which requires less effort. Crop rotation is unknown in Bay region, but there is a regular sequence of cropping in the alternate rainy seasons of Gu and Dayr. Sorghum as well as the other crops like cowpea, are often cultivated in both rainy seasons.

Thirdly, weeding, frequently carried out twice during the growing season, mostly involves the removal of weeds using long-handled yaambo (Plate 5.3). The first weeding is usually done about 3 weeks after the first showers. This delay can be partly explained as a result of heavy rains at the beginning of the growing season, in which the clay soil becomes muddy thus preventing effective weeding at this time. The second weeding, which is often carried out about 5 weeks later, is necessary as the roots of weeds are usually left in the ground and only those above ground are removed.

Fourthly, harvesting is usually undertaken as soon as crops ripen, and mostly when crops are still soft in order to avoid exessive damage caused especially by insects like the stalk borer, and by birds. Crop ears are cut off with knives or by hands just below the panicle and are placed in sacks, while the residue of stalks are left in the fields to be grazed by livestock, especially cattle, once the crops have been completely harvested. Stalks are occasionally collected, especially in the cultivated fields around Baydhabo, in order to be sold for fodder to those town dwellers who keep livestock.

Plate 5.1 A woman scoops holes in the top soil of the farm by using a long-handled *yaambo*. These holes are for seeding at the end of the dry season.

Plate 5.2 A woman seeding by putting about 5 seeds into each hole. The seeds are then covered with a thin layer of soil, using her feet, in order to prevent seed damage caused by wild animals and birds.

Plate 5.3 <u>A group of women (and the researcher) weeding with the long-handled yaambo</u>. The part of the weeds growing above the ground is usually removed while the roots are mostly untouched. Consequently, it is necessary to repeat weeding when a new growth establishes itself again.

Crop storage is the last important element of the dry-farming system in Bay region. Variations in the amounts of rainfall occuring from one growing season to another, as well as the seriousness of crop damage caused by insects and birds, make it necessary to store considerable amounts of crop production to be consumed in times of great needs for food. The traditional method of crop storage is the use of circular ground pits (bakaaro). A typical bakaar (singular of bakaaro) ranges between 5 and 10 feet in diameter, with a depth of up to 8 feet. It is usually filled with the crop and covered with a wooden frame, sorghum stalks and finally soil, forming a dome that rises above ground level (Plate 5.4). This protects the crop from damage caused by the rains. Sorghum is the only crop stored in the bakaar, since this crop is considered as a staple food for the agro-pastoral household. However, the bakaar is usually either lined with sorghum stalks or heated for up to two days, prior to the sorghum being stored, in order to prevent crop damage caused by ground dampness. In addition, sorghum on the heads, which have already been sorted according to their varieties and sun dried, are usually stored in the bakaar. Consequently the sorghum can be stored for up to 5 years without serious damage to grain quality.

5.3 Sizes of Farms

The average size of the cultivated land in Bay region is 1.4 hectares per agro-pastoral household, with a range from less than one-quarter of a hectare to approximately four hectares. This average seems to be relatively larger than in other dry-farming areas of Somalia. For example, the average size of farms in central Somalia is found to be 0.38 hectare per agro-pastoral household (Tylor, 1983). This is probably

Plate 5.4 A dome-shaped crop storage spot in the ground (bakaar), covered by soil and dried branches. This is done to prevent crop damage caused by rains and animal trampling.

due to the annual amount of rainfall which is less in the central areas (less than 200 mm), than in the southern areas (200-600 mm) of Somalia. Nevertheless, in Bay region, it seems that the area of cultivated land varies according to the size of family. Table 5.2 shows a marked tendency for the average size of farm to increase with increased family size. This not only implies that the size of both families and farms develop along parallel lines, but also reflects the increased availability of labour among the larger families to cultivate the larger farms. Consequently, the availability of labour in a household puts a limit on the area of farm that can be cultivated.

Table 5.2 Relationship between family size and the average size of farm in Bay region, 1984.

Family size (persons per household)	Average farm size (hectare)
1 - 4	0.5
5 - 8	1.2
9 - 12	1.9
13 +	2.4

Source: Compiled from the 1984 questionnaire survey.

5.4 Types of Crops

A variety of crops are cultivated in Bay region, including sorghum (*Sorghum vulgare*), cowpea (*Vigna sinensis*), maize (*Zea mays*), sesame (*Sesamum indicum*) and groundnut (*Arachis hyporea*) (Arbuckle, 1968). The most dominant crop is sorghum, since almost all agro-pastoral households cultivate either sorghum alone or in combination with other crops

(Table 5.3). Thus, almost all the dry-farming lands are devoted to sorghum production. It has been reported that about 90 per cent of the tilled land in the Gu (wet) season of 1984, was under sorghum production alone, and the remainder was mostly devoted to the production of cowpea (FEWSD, 1984). This fulfils two important objectives for Bay region's agro-pastoralists: insurance against drought, as sorghum is highly drought-resistant; and a crop which can be stored for long periods. The fact is that sorghum can successfully withstand drier circumstances than, for example, maize. Sorghum has a very deep root system, containing silica, which maintains root form during dry conditions and, as such, it has a greater efficiency of water use than maize (Gibbon and Pain, 1985). Consequently, sorghum can consistently outyield maize under dry-farming systems. Sorghum can also be stored for periods of up to 5 years under the prevailing storage conditions of bakaaro. Sorghum is then the main crop which serves as a staple food for the local inhabitants, in the forms of soor (ground sorghum cooked with milk as a thick porridge), and cambulo (sorghum cooked in water with oil, sometimes with sugar added). Sorghum is not only a source of food, but also a source of cash by selling surplus sorghum yields. Of the two types of sorghum, red sorghum and white sorghum, the red type is preferred by agro-pastoralists. This is mainly because it is harder and less prone to attack from birds. In addition, as the red sorghum is hardier, it can be stored for a longer time compared to white sorghum.

Table 5.3 Crop types cultivated by pastoral households in Bay region, 1984.

Type of crop	No of households	%
Sorghum only	116	52.2
Sorghum & cowpea only	45	20.3
Sorghum, cowpea & maize	21	9.5
Sorghum & maize only	5	2.2
Sorghum, cowpea, maize & others	35	15.8
	222	100.0

The total number of surveyed households: 240.

Source: Compiled from the 1984 questionnaire survey.

5.5 Crop Marketing

The sale of crops is common among the agro-pastoralists of Bay region in order to meet small cash expenses. Table 5.4 shows that more than three-quarters of the households sell at least some of their sorghum production during the year, whilst between about 31 and 35 per cent of the households sell some or all of their production of cowpea, maize, sesame, groundnut and other crops. In this case, cowpea, maize, sesame, groundnut and other crops are mostly cultivated to sustain household needs for food and oil.

In general, sorghum is sold in relatively small proportions, mostly of less than one-quarter of the total production, whilst other crops are often sold in larger proportions of one-quarter of the production and more (Table 5.4). This not only implies that sorghum is an important source of food for consumption within agro-pastoral households, but it is also a source of security against the failure of crops in succeeding years, especially as substantial amounts of sorghum production are stored annually. Thus, the amount of sorghum sold can only cover small cash expenses such as buying non-produced foods (like sugar, tea, coffee and rice), clothes, medicines, kerosene and flashlights. Consequently, agro-pastoralists seldom sell sorghum in order to raise capital to be used as investment to increase crop production or productivity.

Table 5.4 <u>The proportion of crop sold during the year by agro-pastoral households in Bay region, 1984</u>.

Proportion	Number & percentage of households selling crops											
	Sorghum		Cowpea		Maize		Sesame		Ground nut		Other crops	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
None	52	23.4	41	46.5	35	57.4	23	65.7	24	68.6	20	57.1
>1/4	89	40.1	2	2.0	6	9.8	0	0.0	0	0.0	0	0.0
1/4-1/2	33	14.9	12	11.9	6	9.8	1	2.9	2	5.7	3	8.6
1/2-3/4	23	10.4	15	14.9	7	11.5	4	11.4	2	5.7	2	5.7
3/4-all	25	11.2	5	4.9	0	0.0	1	2.9	2	5.7	1	2.9
all	0	0.0	20	19.8	7	11.5	6	17.1	5	14.3	9	25.7
	222	100	101	100	61	100	35	100	35	100	35	100

Source: Compiled from the 1984 questionnaire survey.

5.6 Crop Problems

Agro-pastoralists in Bay region are well aware of the reasons underlying losses and reductions in crop production. There are ten common problems, with six gaining a points-score index of more than 70 per cent. These are weeds, crop damage caused by domestic animals, insects, birds and wild animals, and lack of showers (Table 5.5).

Weeds are the most serious problem associated with dry-farming in the region. The reason for this is that weeding usually takes place too late, often about three weeks after the first showers by which time important moisture and nutrients have already been removed from the cultivated soil. In addition, the roots of weeds are often left in the ground, since weeding only involves the removal of the above-ground parts of the weeds by the hoe. These roots can easily grow up again and, consequently, weeding remains a constant problem for agro-pastoral households primarily because insufficient labour is available to ensure that the optimum amount of weeding is achieved.

The second ranked problem is that of crop damage caused by livestock. This seems somewhat ironic considering that these people specialize in raising animals. This problem is due to the lack of efficient supervision over the animals whilst grazing, especially those animals which are supervised by children. It is also due to the existence of inadequate hedges to protect the farm lands from being trampled by domestic livestock.

Crop damage caused by insects, like the stalk borer (Chilo partellus) and shootfly (Atherigona indica), is the third

Table 5.5 Problems of crop production in Bay region, 1984.

Problems	Very serious		Serious		Neutral		Not serious		Not serious at all		Total points score	Score as % of max.
	No	%	No	%	No	%	No	%	No	%		
1. Weeds	180	81.1	35	15.8	1	0.4	5	2.3	1	0.4	832	93.7
2. Damage by domestic animals	140	63.1	60	27.0	6	2.7	13	5.9	3	1.3	765	86.1
3. Insect damage	139	62.6	60	27.0	7	3.2	12	5.4	4	1.8	762	85.8
4. Damage by birds	145	65.3	32	14.4	12	5.4	29	13.1	4	1.8	729	82.1
5. Damage by wild animals	123	55.4	66	29.7	9	4.1	16	7.2	8	3.6	724	81.3
6. Lack of showers	136	61.3	26	11.7	4	1.8	11	4.1	47	21.1	641	72.2
7. Shortage of labour	20	9.0	31	14.0	8	3.6	33	14.9	130	58.5	222	25.0
8. Soil fertility	17	7.7	29	13.1	11	4.9	33	14.9	132	59.4	210	23.6
9. Storage losses	1	0.4	2	0.9	7	3.2	15	6.8	197	88.7	39	4.4
10. Soil erosion	1	0.4	1	0.4	3	1.3	13	5.9	204	92.0	29	3.3

The total number of surveyed households who practise dry-farming: 222.
Maximum score for any one problem: 888.
Source: Compiled from the 1984 questionnaire survey.

ranked problem. This is primarily because of the short supply of insecticide from the Plant Protection Service. Consequently, trade names, like Basudin, cannot always be afforded by the agro-pastoral households since they do not possess the necessary capital to buy these additional inputs.

Birds are a major hazard to crop production in the region, especially the red billed quelea (Quelea quelea). The aerial spraying of poisons on their nesting sites is used to control this problem, but this method is unworkable at critical times, such as when crops have matured and seeds have been formed on the stalk-heads. Thus, agro-pastoral households attempt to scare these birds in a variety of ways including the use of scarecrows, the flying of kites over the cultivated fields and the production of loud noises (eg. children playing).

Crop damage caused by wild animals is common too in the study area. This ranges from damaging seeds, after planting, by moles, mongoose and squirrels, to damaging growing crops by porcupines, baboons and bush pigs, and damaging crops stored in ground pits by rats and mice. Most agro-pastoral households still use rudimentary techniques against animal pests by frightening those animals away or, if possible, by trapping and killing them.

The lack of showers is also a very serious problem, particularly given the variability of rainfall in such semi-arid lands. The agro-pastoralists are fully employed at the beginning of the growing season, especially when a small reduction in the seasonal amount of rainfall can greatly affect the final production levels of crops. The problems of shortage of labour and low soil fertility show rates of between 23 and 25 per cent, whilst storage losses and soil erosion are reported as not being a markedly serious problem.

5.7 Summary

Analysis in this chapter confirms that crop production, as a second main type of land-use in Bay region, is common, with about 93 per cent of the pastoral households being agro-pastoralists, although it should be borne in mind that dry-farming lands occupy an area of no more than 11 per cent of Bay region's land. This is reflected in the average size of farms, which range between less than one-quarter of a hectare to about four hectares. However, this farming is widely affected by problems such as weed infestation, crop damage caused by birds and insects and other crop problems. As such, crop production is mostly devoted to sustaining household needs for sorghum. The next chapter deals with the third land-use type - wood collection.

CHAPTER SIX

WOOD COLLECTION

6.1 Firewood Collection

Firewood collection is used for cooking purposes and, to a lesser extent, for heating purposes on cool nights. Table 6.1 shows that firewood is easily the most important source of fuel for domestic cooking, with almost all pastoral households using firewood alone or firewood and charcoal together. Indeed, firewood is the dominant cooking fuel over all of Somalia, since more than 80 per cent of the household energy is derived from firewood (Ministry of National Planning, 1982). The importance and the widespread use of firewood over most Somali regions, including Bay region, can only be explained by the fact that firewood is the most available source of fuel, collected freely from the rangelands. The importance of firewood collection can also be found elsewhere in African and Asian rangelands. In the Kordofan region of Sudan, for example, more than two-thirds of the people of the southern areas of the region rely mainly on firewood for their fuel needs (Babiker et al., 1985).

The dead, dry or fallen branches are usually collected for firewood purposes, but the most preferred species are galool (Acacia bussei), tugar (A. nilotica), cadaad (A. senegal). hareeri (Terminalia polycarpa) and mareer (Cordia sinensis), since they give more heat and burn longer. These plant names were reported by the local inhabitants during the 1984 field work and were very similar to the available plant inventory produced by Hunting Technical Services (Vol. 2, 1982) for

Bay region. The only alternative fuel for cooking in the study area is charcoal, but this is only used on a very limited scale, mainly because charcoal is produced by individuals, from whom the pastoral people make purchases, and this is an unnecessary expense in those areas where the firewood is abundant. Neither kerosene nor animal dung are used for cooking purposes by the pastoral households in Bay region, as appears to be the case among other pastoral groups elsewhere in African and Asian rangelands (Thalen, 1979; Hammer, 1980).

Table 6.1 The type of fuel used for domestic cooking by pastoral households in Bay region, 1984.

Type of fuel	No. of households	%
Firewood	233	97
Firewood and charcoal	7	3
	240	100

Source: Compiled from the 1984 questionnaire survey.

The use of kerosene is limited to the lighting of kerosene lamps only. There is a general shortage of kerosene in the rural areas of Somalia, but, in any case, most pastoral households cannot afford this fuel in the amounts required for cooking purposes and, therefore, it is only used for lighting purposes. Animal dung is considered as inappropriate for cooking purposes. This state of affairs then gives rise to the following question: does the reliance on firewood mean that there is no fuelwood problem in Bay region? This question will be answered in section 9.5 of this study.

Firewood is collected by family females from nearby woodlands, within a distance of less than 2 kms in most cases. About 78 per cent of the pastoral households collect their firewood needs within this radius (Table 6.2). In some cases, the search for firewood extends for 4 kms and more as a result of the overcutting of woody plants in the vicinity of settlements, and the increased clearance of rangelands for farming practices, as reported in the villages Mataana, Awdheere and Korunbod during the 1984 field work. Nevertheless, this condition is not as serious as in other range areas in the Middle East (Pearce, 1970), East Africa (Strange, 1980c) and Southern Africa - Botswana (Listner, 1984), where pastoral women have to travel about 10 kms or more in order to gather firewood.

The search for firewood is not only to satisfy household needs for cooking purposes, but, in addition, the pastoral women occasionally sell firewood at the main markets of Baydhabo and Bur Hakaba, for about 10 Somali Shillings per bundle. Each bundle contains roughly 15 pieces of firewood, of lengths of about half a metre. As such, the sale of firewood is an extra source of income for pastoral households. In fact, some pastoral households, accounting for about 7 per cent of the sample are frequently involved in the sale of firewood. Donkey carts loaded with firewood were frequently observed in the main town areas of Bay region, especially Baydhabo, during the 1984 field work (Plate 6.1). This commercial collection of firewood is influenced by two factors: firstly, those households who are involved in this type of firewood collection are in need of cash, especially during the dry seasons when the production of milk is at its lowest. Secondly, the demand for firewood,

Plate 6.1 <u>Cart loads of firewood being taken for sale to the market at Baydhabo</u>. This is another source of income for pastoral households. Each load can be sold for approximately 200 Somali Shillings.

found mainly in town areas, encourages those pastoral households who live in the neghbouring range areas to involve themselves in the commercial collection of firewood. Thus, the woodlands of Bay region are not only a main source of firewood for those pastoral inhabitants, but also for the town dwellers.

Table 6.2 The nearest supply of firewood for the households in Bay region, 1984.

Distance (in kms)	No. of households	%
less than 2	188	78.3
2 - 4	36	15.0
4 +	16	6.7
	240	100.0

Source: Compiled from the 1984 questionnaire survey.

6.2 Timber Collection

The woody plants of Bay region also provide a supply of timber, especially for house building, fences and animal pens. The results of the 1984 questionnaire survey show that almost all pastoral households depend on the locally available woody resources of the nearby woodlands in constructing their houses and fences. For example, the fine branches and poles of galool, dhamaaq, mareer and mere oor gaabo are used for making the portable nomadic huts of agallo (Plate 6.2) and the fixed round wattle and daub huts of mundullo (Plate 6.3). Timber is often collected from woodlands of 4 kms and more away from the settlement, with about 56 per cent of the pastoral households collecting

Plate 6.2 This is an agal (singular of agallo) hut inside the rangelands. It has a globe shape made with branches that are bent to shape, and it is covered with layers of hide and thatching. This type of hut is portable and, as such, is useful during the pastoral movements.

Plate 6.3 A permanent mundul (singular of mundullo) hut. It has a rounded base with the lower part covered by wattle and daub. The roof is conical in shape and thatched. This type is quite common amongst the agro-pastoral groups of Bay region.

their needs for timber within this distance (Table 6.3). This can be explained as a result of the continuous collection of firewood in the nearest woodlands in which the required branches and poles for building purposes are scattered. Thus, timber collection is mostly carried out in woodlands lying beyond the firewood collection belt.

Table 6.3 The nearest supply of timber for pastoral households in Bay region, 1984.

Distance (in kms)	No. of households	%
less than 2	19	7.9
2 - 4	29	12.1
4 +	19	80.0
	240	100.0

Source: Compiled from the 1984 questionnaire survey.

6.3 Charcoal Production

The production of charcoal is officially carried out under the supervision of the Somali government, with the National Range Agency (NRA) providing permission to the local contractors. In 1984, there were about 72 charcoal producing units with 10-20 workers in each. The granting of permission allows the contractor to use only dead, dying and diseased woody plants for charcoal production, and this has to be from a pre-specified woodlot and then for only 3 years before moving to a new woodlot. In practice, green trees and bushes are also cut in order to generate greater profits by producing more charcoal, in spite of the fact that soft wood requires more heat to carbonise it (Morgan and Moss, 1981).

The area of woodland currently permitted for these purposes is not more than 25 square kilometres and, as such, only 4.5 per cent of Bay region land was officially used for charcoaling in 1984. Charcoal production, therefore, has been limited in the study area to the north, north-eastern and north-western parts of the region (see Chapter 3).

The production of charcoal is well-organized in Bay region, although unsophisticated methods such as earth kilns, have been adopted for charcoaling, owing mainly to the small levels of investment made in equipment for the process of charcoaling. Acacia trees and bushes such as A. bussei, A. senegal, A. nilotica and A. tortilis are felled with axes, but these tools are much less effective and efficient in comparison with more sophisticated ones such as the motor saw, widely used by the charcoal workers in some African areas in the western part of Nigeria (Ay, 1980). Usually the stumps (less than 50 cm above ground) are not removed, but, on the other hand, they may require a long period of time to regrow since these stumps are not protected from the pressure of animal grazing and trampling.

Earth kilns are the only method used for charcoaling in Bay region, as elsewhere in Somalia (Plate 6.4). These structures are temporary because they are useful for only one firing. Therefore, several earth kilns are dug within a field for a season of charcoal production. Nevertheless, this method is considered to be the cheapest means of producing charcoal (Openshaw, 1978). The size of earth kilns varies considerably, with diameters ranging between 2 and 10 metres depending on the amount of wood to be charcoaled. A big kiln indicates an area with a high standing volume of Acacia trees and bushes, and a small kiln is found where

Plate 6.4 An earth kiln for charcoal production in the northern parts of Bay region. The size of this kiln produces roughly six tons of charcoal.

these woody species are more sparse. Thus the production of kilns varies too, and ranges between 4 and 14 tons with a mean production of 6 tons. In this case, charcoal production from the earth kilns in the study area is much larger than elsewhere in Africa. In some parts of Nigeria, for example, the production of charcoal per kiln in most cases is only about 2 tons (Ay, 1980). Acacia trees and bushes in Bay region are exploited over a wide area for charcoal production, compared with other African areas. A common problem is that the wood may not always be fully carbonized and, as such, it can be classified as pre-burnt firewood, as reported by the relevent officials of NRA in the 1984 field work. The reason for this is that the wood is not cut into uniform lengths nor is it split, and so there is a wide variation of dimensions being coaled at the same time. Consequently, the quality of charcoal produced may be much reduced.

No accurate statistics are currently available on charcoal production in the study area, nor for the matter in Somalia. Nevertheless, respondents in the 1984 survey suggested that about 75 per cent of the charcoal production in Bay region, and the neighbouring areas, was in 1983 transported to the consumer centre of Mogadishu (Plate 6.5). Thus, Mogadishu dwellers are major consumers of charcoal produced in Bay region and, as such, charcoal plays only a minor role in total household energy consumption within the study area. The available figures of charcoal transported to Mogadishu from Bay region, and areas around, may reflect the general trend of the production in these regions.

Plate 6.5 <u>Carrying approximately 28 tons of charcoal</u>. This lorry and trailer is on its way to Mogadishu from the charcoaling areas in and around Bay region.

Table 6.4 Charcoal transported to Mogadishu from Bay and neighbouring regions (in tons).

Year	Quantity
1977	27065
1978	36559
1979	27028
1980	28459
1981	28716
1982	30097
1983	42162

Source: Unpublished data obtained in 1984 from the National Range Agency, Mogadishu.

Table 6.4 shows clearly that there has been an increase in the amount of charcoal produced and exported from Bay region and the surrounding areas to Mogadishu during the 6-year period from 1977 to 1983, with an increase over that period of about 56 per cent. This implies that large numbers of Acacia trees and bushes have been exploited for charcoaling in those regions. Two questions consequently arise: is this increase the result of population growth in Mogadishu or is it the result of significant new planting of Acacia trees and bushes? These questions will be discussed in Section 9.6 of Chapter Nine.

6.4 Summary

Analysis in this chapter is focused on wood collection, as the third main form of land-use in Bay region. Wood collection for household purposes is carried out freely by pastoral groups from nearby woodlands. Firewood is often collected from the nearest woodland, whilst timber for household building and fences, is usually gathered from further afield. Charcoal production is another form of wood collection in Bay region, but, in 1984, only 4.5 per cent of the region's land was officially used for charcoaling. However, Bay region is one of the major suppliers of charcoal production to the consumer centre in Mogadishu. With the main land-use types covered by Chapter Four to Six, Chapter Seven attempts to discuss land-use changes in a broader context.

CHAPTER SEVEN

LAND-USE CHANGES IN BAY REGION

7.1 Introduction

The previous three chapters have highlighted some of the main changes which have occured in the agro-pastoral farming systems in Bay region. These changes include a growth in the numbers of livestock in general, and cattle in particular; an extension in the area of dry-farming lands; and an increase in the production of charcoal. This chapter discusses perceptions of these land-use changes among people in Bay region, and also attempts to test interrelationships between a number of selected ecological and socio-economic factors.

7.2 Perceived Land-use Changes

A list of 41 selected ecological and socio-economic factors or indicators, and how these have been perceived to have changed over the past 20 years in Bay region, has been derived from the opinions of the local inhabitants. Furthermore, these perceptions are examined in the light of how they may differ from objective reality (Appendix 2). Some of these perceived changes have already been discussed in earlier chapters, but they are discussed further in this section, where appropriate, for the purposes of comparison.

These 41 indicators have been been ranked according to their percentage points-scores. Consequently, factors with a score of above 50 per cent show some level of decrease in their importance as a perceived problem or phenomenon compared with 20 years ago. Factors with percentages of below 50 suggest an increase in the importance of the perceived problem or phenomenon. For ease of analysis these 41 factors have been divided into three land-use groups: animal grazing, dry-faring and wood collection (Tables 7.1, 7.2 and 7.3).

Perceptions concerned with livestock grazing are presented in Table 7.1. The numbers of cattle have been perceived to have increased markedly over the last 20 years (points-score of about 37 per cent) and the numbers of camels have been perceived to have increased similarly (points-score of about 40 per cent). There appears to be a less strong perception of increases in smallstock, but this may be more because children and women of pastoral households generally care for the goats and sheep, and so their accurate numbers remain unknown to the heads of households who have little interest in smallstock.

The greater increases in cattle numbers, as compared to camels, can be related to the fact that veterinary services have been improved, and that the numbers of watering points have increased during the last 20 years. It seems that veterinary services have mostly dealt with improving the health of cattle, since rinderpest and tsetse-fly infestation, which bring danger to cattle in particular, have been significantly reduced in Bay region. Increases in the numbers of watering points have been brought about by an increase in the number of wells and <u>waro</u> which are essential for cattle rearing, as cattle have a more frequent intake of water than other types of livestock, especially camels (see Chapter 4). In this respect, cattle seldom wander far from watering points on the range, owing to their persistent

Table 7.1 Perceived land-use changes relating to livestock grazing in Bay region, 1984.

Factors	Total points score	Score as % of max.
1. There was more range forage 20 years ago	850	88.5
2. Rinderpest was a greater problem 20 years ago	744	77.5
3. Tsetse-fly infestation was a greater problem 20 years ago	649	67.6
4. There were more pastoral movements 20 years ago	635	66.1
5. There were more pastoralists 20 years ago	593	61.8
6. There were more smallstock 20 years ago	484	50.4
7. Anthrax was a greater problem 20 years ago	479	49.9
8. Foot & mouth disease was a greater problem 20 years ago	454	47.3
9. Trypanosomiasis was a greater problem 20 years ago	446	46.5
10. Haemorrhagic septicaemia was a greater problem 20 years ago	444	46.2
11. Bovine & caprine pleuropneumonia were a greater problem 20 years ago	431	44.9
12. Black - quarter was a greater problem 20 years ago	429	44.7
13. There were more camels 20 years ago	389	40.2
14. Animal diarrhoea was a greater problem 20 years ago	379	39.5
15. Helminthiases was a greater problem 20 years ago	372	38.7
16. There were more cattle 20 years ago	352	36.7
17. There were more pastoral settlements 20 years ago	191	19.9
18. There were more animal slaughter 20 years ago	136	14.2
19. There were more soil erosion 20 years ago	108	11.2
20. Tick - borne diseases were a greater problem 20 years ago	87	9.1
21. There were more *waro* 20 years ago	82	8.3
22. There were more wells 20 years ago	77	8.0
23. There were more animal sales 20 years ago	62	6.5
24. Veterinary services were better 20 years ago	28	2.9

Source: Compiled from the 1984 questionnaire survey.

Table 7.2 Perceived land-use changes relating to dry-farming in Bay region, 1984.

F a c t o r s	Total points score	Score as % of max.
1. Crop damage caused by locusts was a greater problem 20 years ago	921	95.9
2. Soil fetility was better 20 years ago	771	80.3
3. There were more areas under cultivation 20 years ago	346	36.0
4. Crop damage caused by insects was a greater problem 20 years ago	337	35.1
5. Crop damage caused by birds was a greater problem 20 years ago	266	27.7
6. There were more pastoral settlemants 20 years ago	191	19.9
7. There were more agro-pastoralists 20 years ago	178	18.5
8. There was more soil erosion 20 years ago	108	11.2
9. Agricultural services were better 20 years ago	41	4.3
10. weeds were a greater problem 20 years ago	37	3.8

Source: Compiled from the 1984 questionnaire survey.

Table 7.3 Perceived land-use changes relating to wood collection in Bay region, 1984.

F a c t o r s	Total points score	Score as % of max.
1. There were more woody plants 20 years ago	793	82.6
2. There were more pastoral settlements 20 years ago	191	19.9
3. There were more firewood collection 20 years ago	126	13.1
4. There was more soil erosion 20 years ago	108	11.2
5. There was more charcoaling 20 years ago	40	4.2

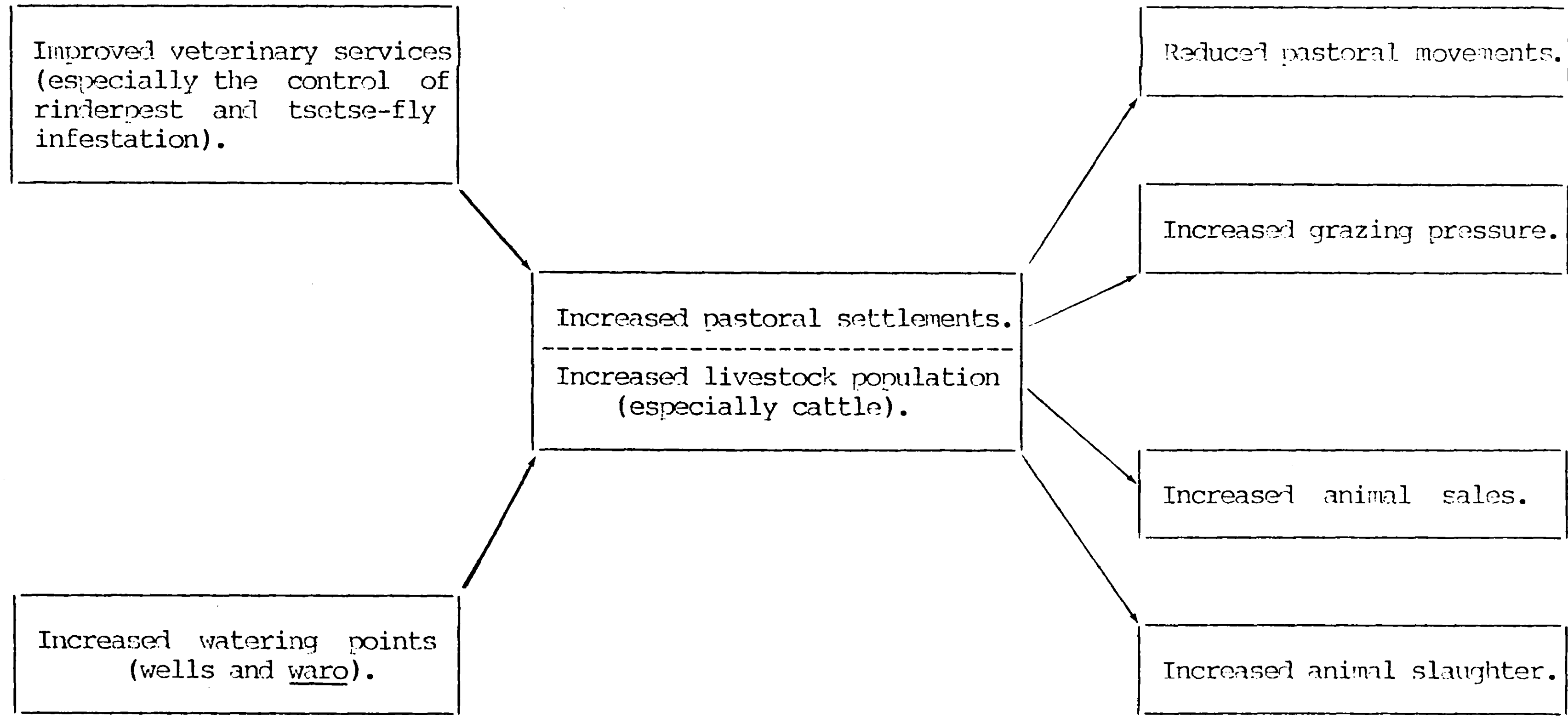
Source: Compiled from the 1984 questionnaire survey.

needs for water, and therefore, as cattle have become relatively more important in the Bay rural economy, pastoral movements have been correspondingly reduced. This implies that pastoral people have additional time which had formerly been spent on supervising animal grazing.

On the other hand, the general increase in the number of livestock has put a higher pressure on the rangeland resources themselves, despite an increase in animal sales and slaughter (Figure 7.1). The increased grazing pressure results in the perceived decline in both the quantity and quality of range forage and the noticeable increase in soil erosion. The decline in range forage supply can also be related to the perceived decline in rainfall amounts (Appendix 2). Rainfall plays an important role in the productivity of rangelands, especially range forage availability, but the general perception among people in Bay region of rainfall decline in the region, raises the very important question of whether there has indeed been a real and objective reduction in rainfall amounts in Bay region and areas around over the past 20 years, or whether the perceptions of Bay region residents may be misleading.

The second group deals with the perceived land-use changes relating to dry-farming (Table 7.2). The perception that there is more land under cultivation now than 20 years ago can be related to an increase in the provision of agricultural services, as well as the increased settlement of pastoralists in Bay region. Agricultural services have mostly involved the control of the locust problem which was perceived to be worse 20 years ago (96 per cent points-score) , since other crop problems, such as bird and insect damage, have increased as perceived by the local

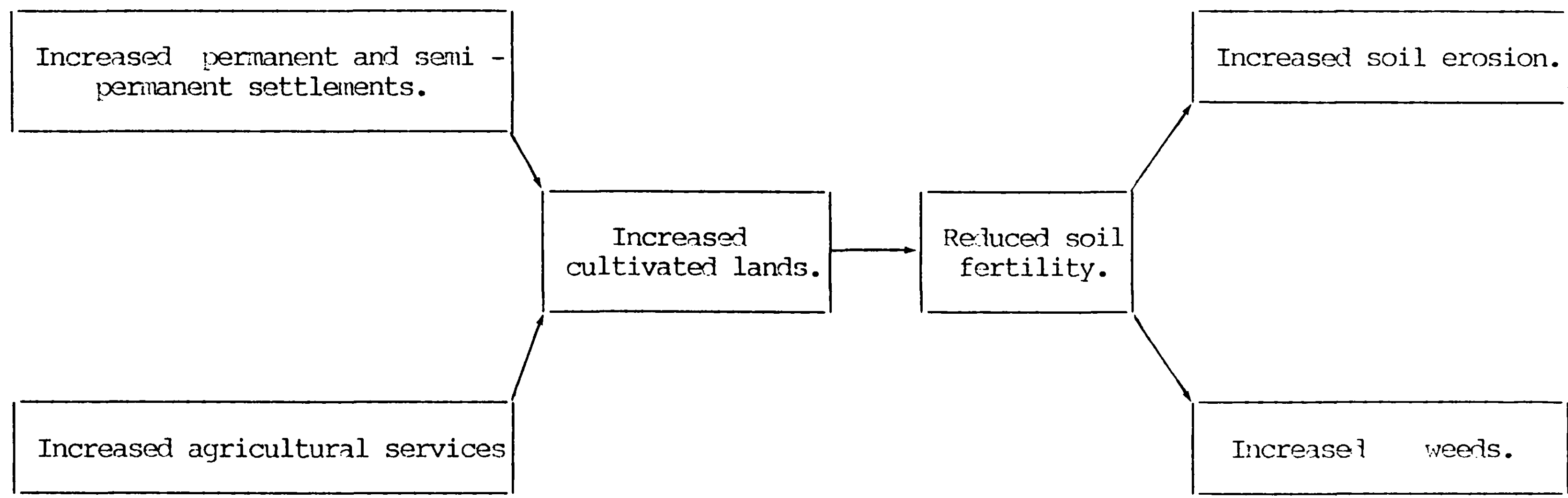
Figure 7.1 Factors relating to increased grazing practices in Bay region.



inhabitants. The increase in the number of pastoral settlements has come about because of the increase in the number of watering points in the region, and the associated reduction in both the scale and geographic spread of pastoral movements. Consequently, herdsmen, freed from tasks relating to animal husbandry, are diverting their labour to other land-use activities, mainly dry-farming. Such activities are not related to pastoralism, but, over the long term, they have tended to become one of the main sources of livelihood for many agro-pastoral groups in Africa (Khogali, 1981). This cultivation also benefits cattle herds, since they can graze on the crop residues after harvesting, as well as on range forage available around the pastoral settlements, especially during the rainy seasons (Swift, 1977a).

However, the extension in crop cultivation has led to a perceived reduction in the fertility of the cultivated soil, as traditional farming techniques are used (see Chapter 5), in which the problems of soil erosion and weeds has, in turn, increased (Table 7.2 and Figure 7.2). In spite of the perceived decline in rainfall, compared with 20 years ago (Appendix 2), there has nevertheless been an increase in the area of dry-farming lands. This is difficult to explain, if perceptions are correct, given that this form of agriculture is completely dependent on rainfall for crop production in Bay region. Ironically, the lack of rain showers is considered to be one of the main crop problems in the region (see Chapter 5), but nevertheless, despite the general perception of the decline in rainfall amounts over the last 20 years, the area of rainfed, cultivated land has actually expanded over the same time-period.

Figure 7.2 Factors relating to increased dry-farming practices in Bay region.



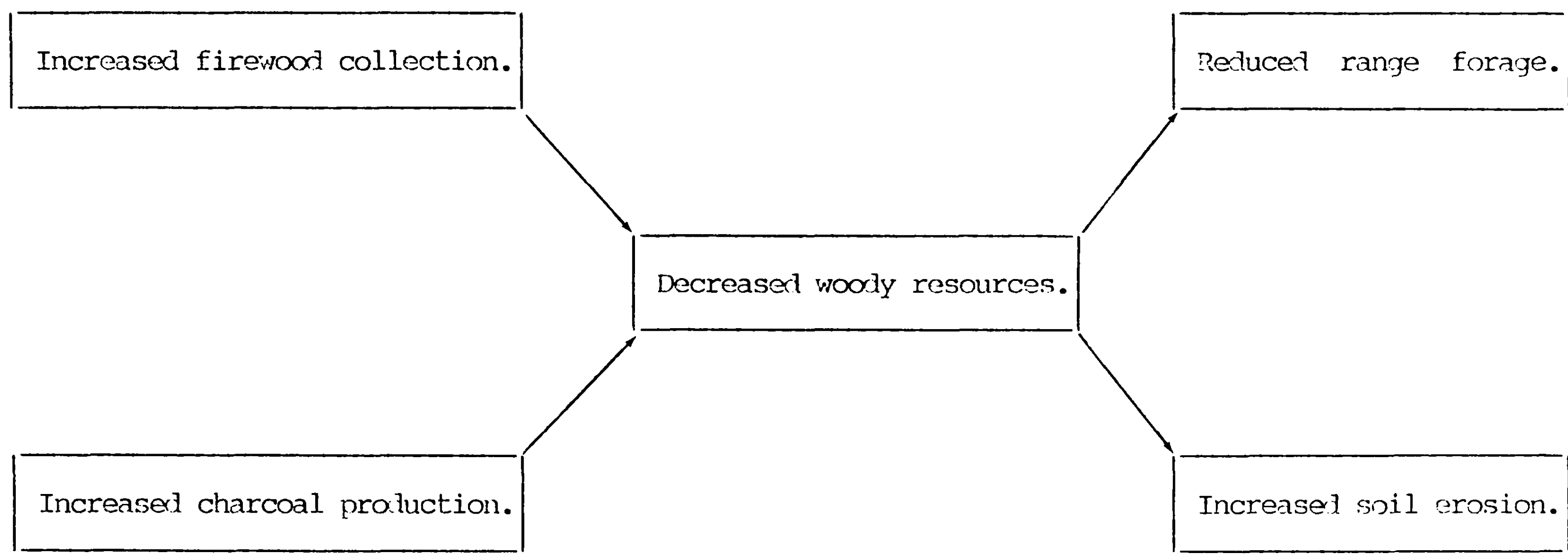
The third group deals with the perceived land-use changes relating to wood collection (Table 7.3). The perception of decreased woody resources (points-score of 82 per cent) can be attributed to increases in firewood collection and charcoal production. This has resulted in the reduction of the availability of range forage and an increase in erosion processes on the rangelands (Figure 7.3).

Analysis of these three groups of perceived changes over 20 years suggest that there has been an increase in human influences on the rangeland ecosystems in Bay region, rather than any significant changes in environmental factors themselves, such as rainfall. There has been an actual increase in the use and exploitation of rangelands for grazing, dry-farming and wood collection practices. Furthermore, most of the associated problems with these land-use types have not yet been solved, and, in many cases, they show some increase in their perceived levels of seriousness, compared with 20 years ago. Part Three of this study will go on to attempt to explain these land-use changes.

7.3 Interrelationship Between Some Ecological and Socio-economic Variables Relating to Land-use Changes

A number of factors or indicators concerned with land-use changes were carefully chosen as those most likely to display some interrelationships, by using the Chi-square test statistic. The list of variable pairs tested and the confidence level of relationship are shown in Table 7.4. Cells with expected values of less than one constituted a major problem in the use of the test statistic. In order to solve this problem, each two columns 'agree strongly' and

Figure 7.3 Factors relating to increased wood collection practices in Bay region.



'agree'; 'disagree' and 'disagree strongly' were joined together and the neutral column was discarded (see Appendices 3, 4, 5, 6 and 7).

Only five significant interrelationships were revealed, and two of these were significant at only the 0.05 level of confidence (Table 7.4). Clearly, there is no association between most of the tested variables. This observation may appear contradictory to the earlier conclusions from the analysis of relevant factors. These variable factors are, in fact, independent as there is no significant interrelationship between most of them. This is curious, because there should be some measure of relationship between these chosen variables, such as between the increase in cattle population and the reduction in rinderpest problem, and between the increase in firewood collection and the decrease in woody plants. Thses changes, however, require futher explanations which are included in the next chapters of this study.

Table 7.4 Significant Chi-square interrelationship between selected ecological and socio-economic variables relating to land-use changes in Bay region, 1984.

Relationship	Confidence level 0.05	0.01
1. Rainfall & range forage	-	-
2. Wells & pastoral settlements	-	-
3. Areas under cultivation & agro-pastoralists	-	-
4. Areas under cultivation & pastoral movements	-	-
5. Wells & pastoral movements	-	-
6. Cattle & range forage	x	-
7. Cattle & veterinary services	-	-
8. Cattle & tsetse-fly infestation	-	-
9. Cattle & rinderpest	-	-
10. Cattle & animal sales	x	-
11. Cattle & animal slaughter	-	-
12. Cattle & agro-pastoralists	-	-
13. Cattle & pastoral movements	-	x
14. Cattle & areas under cultivation	-	-
15. Cattle & wells	-	-
16. Firewood collection & woody plants	-	-
17. Firewood collection & areas under cultivation	-	x
18. Firewood collection & pastoral settlements	-	-
19. Charcoal production & woody plants	-	-
20. Charcoal production & migration to towns	-	-
21. Charcoal production & road networks	-	-
22. Road networks & areas under cultivation	-	x
23. Road networks & migration to towns	-	-
24. Road networks & communication between pastoral groups and goverment agents	-	-

x^2 shows a significant interrelationship at either 0.05 or 0.01 level of confidence.

Source: Computed from the results of the 1984 questionnaire survey.

7.4 Summary

The above discussion has been concerned with showing the changes which have been perceived by local inhabitants to have occurred in the use of rangelands in Bay region during the past 20 years. There are 41 ecological and socio-economic variables relating to land-use changes in the region, and it would seem that these land-use changes are more likely to be as a result of human activities, rather than a result of changing environmental factors. The increase in human activities, in the forms of grazing, dry-farming and wood collection, is largely responsible for the decline of range forage, soil fertility and woody plants. With the three main types of land-use and the associated changes covered by Chapter Three to Seven, Part III will focus on the explanations of land-use changes in Bay region.

PART III EXPLANATIONS OF LAND-USE CHANGES

CHAPTER EIGHT

ENVIRONMENTAL FACTORS

8.1 Climate

This section discusses the ways in which climatic factors have affected land-use changes in Bay region over the last 20 years, with a focus on rainfall, as this is the most variable element in the climate of arid rangelands. There are only four climatic stations in Bay region (Figure 8.1), and these are not only unevenly distributed, but, in addition, their meteorological records are not continuous or are of only short-term series (Figure 8.2). Furthermore, these records are problematic because they were mostly hand-recorded and were unchecked, and therefore contain some errors, an inevitable problem in using recorded data from such countries. Most of the meteorological data deal with rainfall alone, with little reference to temperature, humidity, evaporation, cloud cover, pressure and wind patterns in Bay region. It is clear that the region has been as badly served by the Meteorological Survey as elsewhere in Somalia. It therefore, becomes necessary to use the meteorological data from neighbouring stations outside the study area, notably Bardeera and Afgoye (Figure 8.1) to supplement the examination of rainfall conditions in the study area. However, the meteorological data of Baydhabo, Bardeera and Afgoye stations have only been used in the present analysis as they cover a longer period of observations compared to records covered by other stations.

Temperature data do not show a major variation between the warmest and the coldest months. This is due to the

Figure 8.1: Location of the climatic stations in Bay region and surrounding areas.

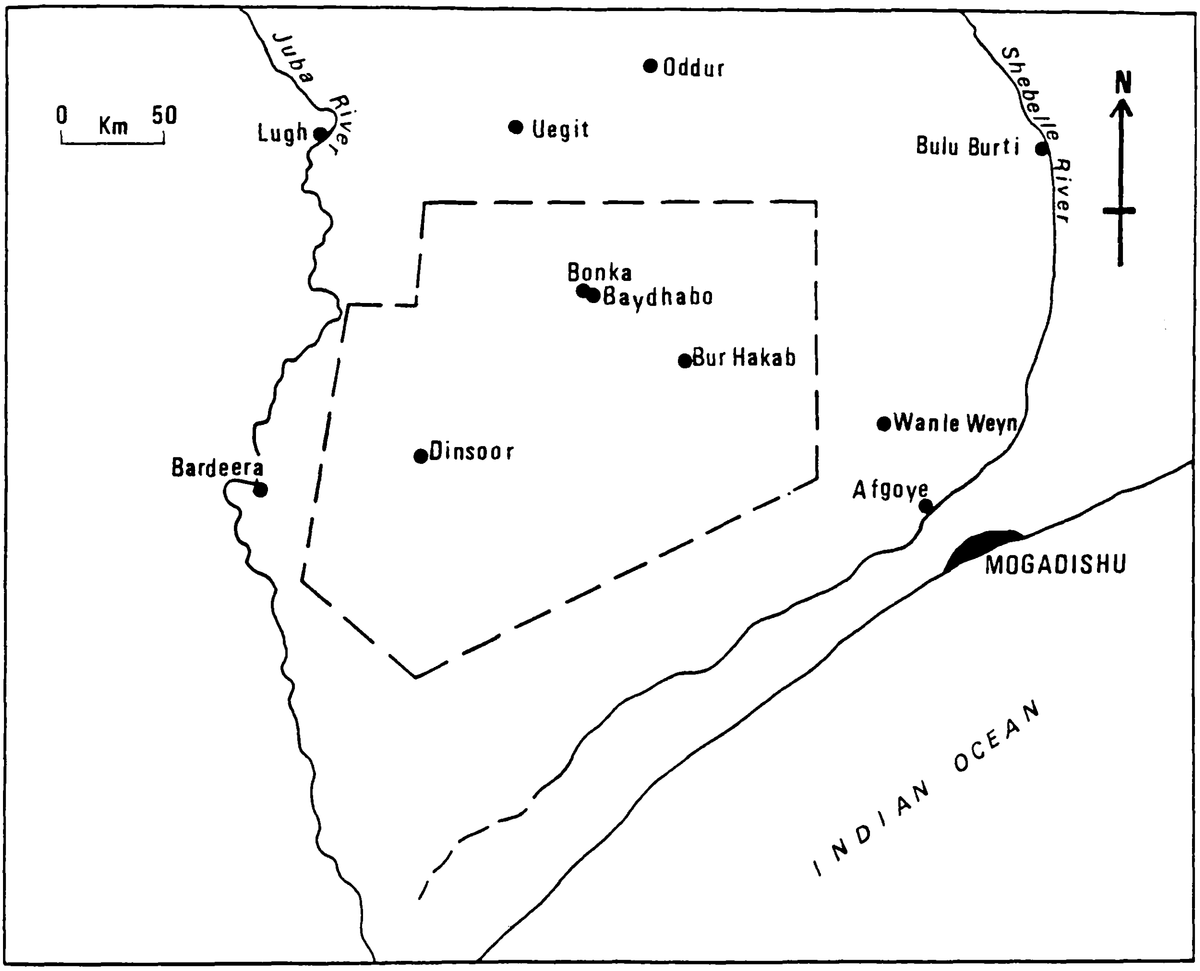
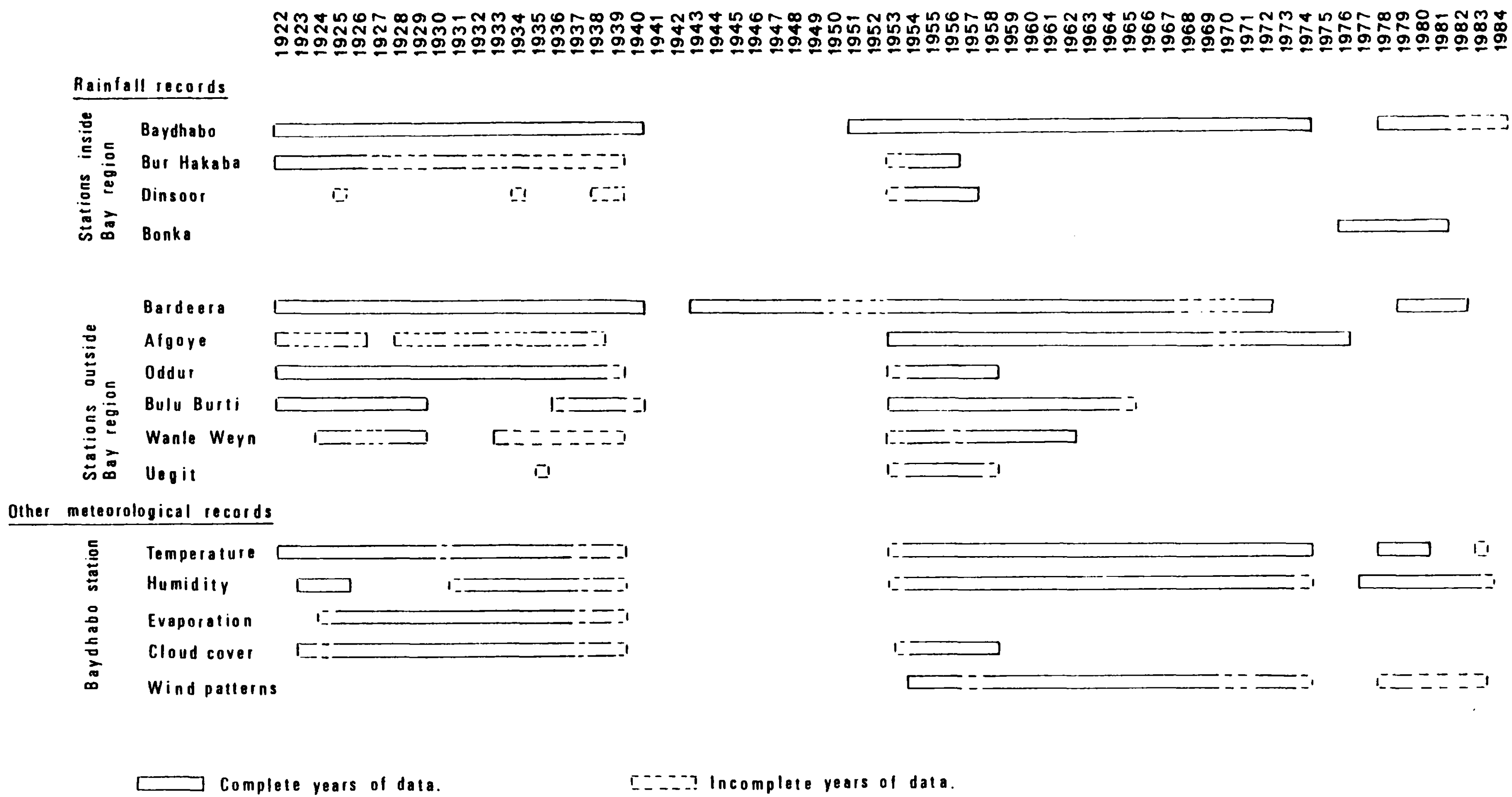


Figure 8.2: Meteorological records availability in Bay region and surrounding areas.



latitudinal location of Bay region near the Equator. Nevertheless, despite the small annual range of temperature, the daily variation can be as much as 10^{o} centigrade in July, and even higher in the drier months of January and February, with about 15^{0} C. The reasons for this are, firstly, Baydhabo station and the Benadir coast, located along the coastal stretch from north of Mogadishu to north of Kismayo, are about 300 kms apart and consequently Baydhabo lies beyond the influence of the sea, this effect is felt for only about 150 kms inland (ICA, 1961). This means that only the southern part of Bay region comes under maritime influences, since the nearest point from the southern boundaries of the region and the Banadir coast are about 120 kms apart. Secondly, the sky is relatively free of cloud all the year round, since the annual mean of cloud amounts at that station is about five-tenths. These two factors may lead to an increase in the heat of the earth during the day and enable it, at the same time, to reduce it quickly during the night. In Baydhabo, according to the temperature records built up over 39 years, there has been no change in temperature in the last 20 years. Consequently, the findings of this study do not confirm those of Hemming (1966), in the northern part of Somalia and the surrounding areas, in which he indicated that an increase in the temperature, together with a reduction in the rainfall, have recently taken place in Aden which lies in the extreme south-west of Asia. On examination of the temperature data of neighbouring climatic stations, such as at Bardeera and Afgoye, there have been no marked changes in temperature. Hemming 's study, indeed, did not emphasise that the trend of change in temperature is general all over the northern part of Somalia and areas around.

Bay region is part of the Horn of Africa and consequently it lies throughout the year under the effect of the prevailing atmospheric pressure over the surrounding areas. Wind direction data for Baydhabo station show that north-easterly winds dominate during the period of December-March (Jilaal season). This wind is part of the north-east monsoon wind which blows over Somalia in that period owing to high pressure over south-east Asia and the low pressure over central Africa (Griffiths, 1972). This monsoon wind, however, brings dryness to Bay region and the surrounding areas, since it blows from the desert of the Arabian Peninsula. The wind system is quite different during the period of June till September (Hagai season), where Baydhabo is affected by the south-westerly monsoon wind. The origin of this wind is in the south-east, but its direction physically changes by passing the Equator. This monsoon wind rarely causes rainfall over Somalia's territory because it blows along the coastline and does not penetrate inland. The wind direction during the short intervening period of April-May (Gu season) and October-November (Dayr season) is generally changeable from the south-east to the south which coincides with the passage of the ITCZ. The ITCZ

has considerable potential for rainfall, enabling much of the range areas of Bay regions to be used for animal grazing and crop production.

The available rainfall records of Baydhabo, Bardeera and Afgoye stations have been analysed by dividing the series at each station into groups of 5-year periods, although some groups contain fewer than 5 years, and others record more due to the existence of missing data for some years. For example, the rainfall records at Baydhabo have been grouped into seven 5-year periods and three 4-year periods, because of interruptions in the 47-year series (Table 8.1). This division is used to interpret rainfall conditions monthly and yearly in both short and long terms. Also, quantitative techniques including the median, the arithmetic mean, the standard deviation and the coefficient of variation are used in the analysis of rainfall observations. Further inferential statisics, such as rainfall predictions are used, because it is essential to recognize that rainfall in semi-arid areas is highly erratic.

Annual rainfall in Bay region and neighbouring areas shows, firstly, that the mean annual rainfall ranges between about 200 mm and 600 mm (Figures 8.3, 8.4 and 8.5), showing quite a considerable variation within the small geographic area of Bay and neigbouring regions. This results in a marked variation in the annual productivity of rangelands in terms of range forage, fuelwood and timber production from one area to another. The movement of pastoral people and their animals within and around Bay region is a necessary response in order to make full use of range resources, especially range forage.

Secondly, the annual values of the short-term mean vary greatly at each station. The 5-year means at Baydhabo range between 516.8 and 777 mm of rainfall, a difference more than 250 mm of rainfall (Table 8.1). At Bardeera and Afgoye, the differences between the lowest and the highest 5-year means are more than 300 mm (Tables 8.2 and 8.3). These variations are clearly reflected in other ways. For example, at Baydhabo the 5-year median ranges between 458 and 670 mm of rainfall, while the 5-year values of standard deviation range between 90.9 and 339.3 mm of rainfall with coefficient of variation ranging between 14.8 and 43.7 per cent. Also,

Table 8.1 Annual rainfall variability characteristics for Baydhabo station (inside Bay region).

Periods	No of years observation	Median (mm)	Mean (mm)	Standard deviation (mm)	Coefficient of variation (%)	Lowest rainfall (mm)	Highest rainfall (mm)
1922 - 1926	5	670.0	777.0	339.3	43.7	462.0	1217.5
1927 - 1931	5	458.0	524.8	217.0	41.4	367.0	896.5
1932 - 1936	5	438.5	516.8	177.7	34.4	363.0	803.1
1937 - 1940	4	481.1	516.5	187.3	36.3	328.4	775.3
1951 - 1955	5	547.4	609.0	264.2	43.4	315.1	998.0
1956 - 1960	5	520.1	548.9	191.6	34.9	314.6	759.5
1961 - 1965	5	540.1	612.2	192.3	31.4	333.9	881.8
1966 - 1970	5	574.5	613.4	90.9	14.8	522.4	728.0
1971 - 1974	4	375.0	413.0	197.6	47.8	214.9	686.9
1978 - 1981	4	437.7	639.4	273.9	42.8	317.9	970.8
Long - term	47	534.4	580.5	219.7	37.9	214.9	1217.5

Source: Before 1960 computed from Fantolli (1965: 278); after 1960 computed from unpublished records of Meteorological Service, Civil Aviation Dept., Ministry of Land and Air Transport, Mogadishu, 1984.

Figure 8.3: Annual rainfall totals for Baydhabo station.

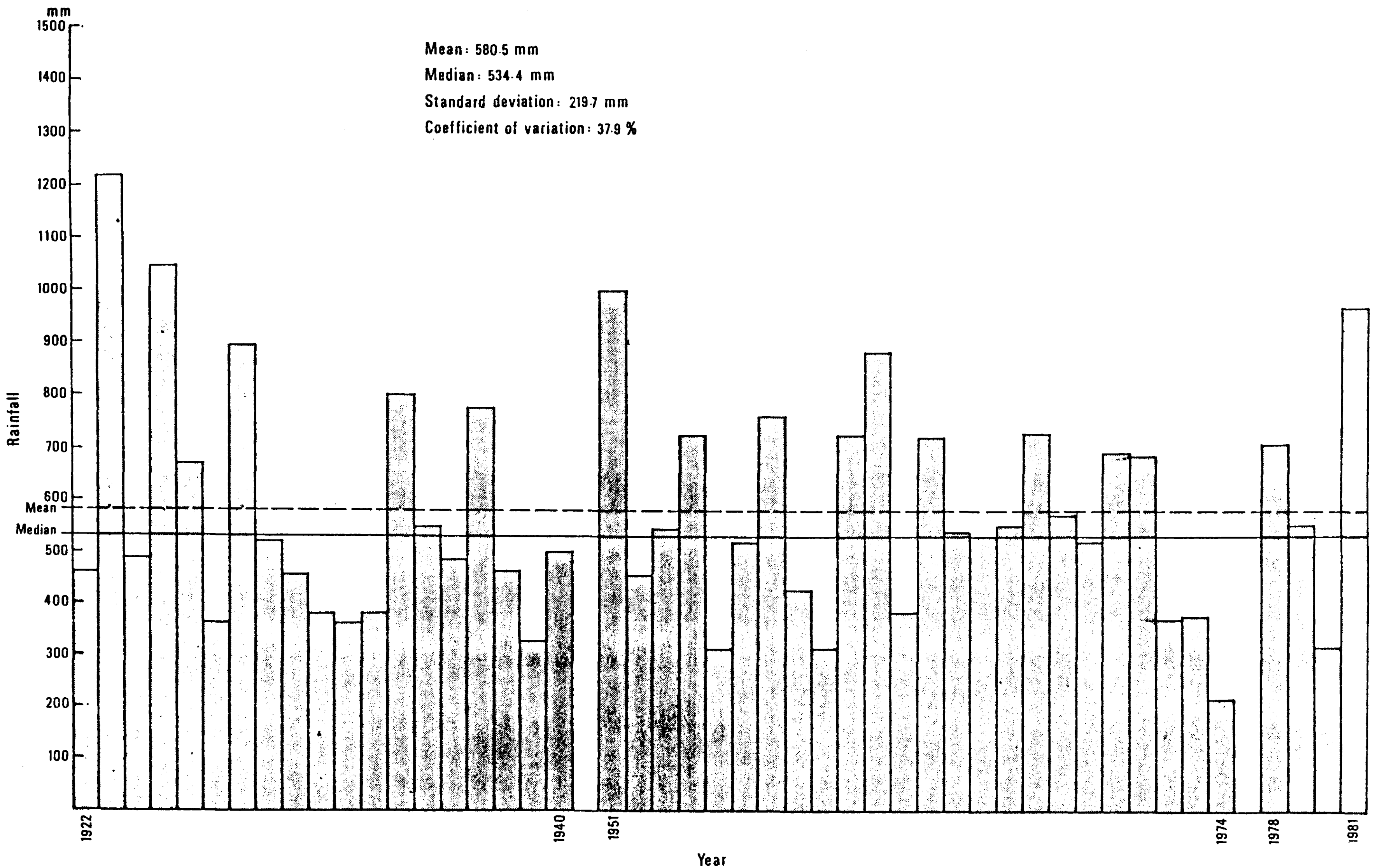


Figure 8.4: Annual rainfall totals for Bardeera station.

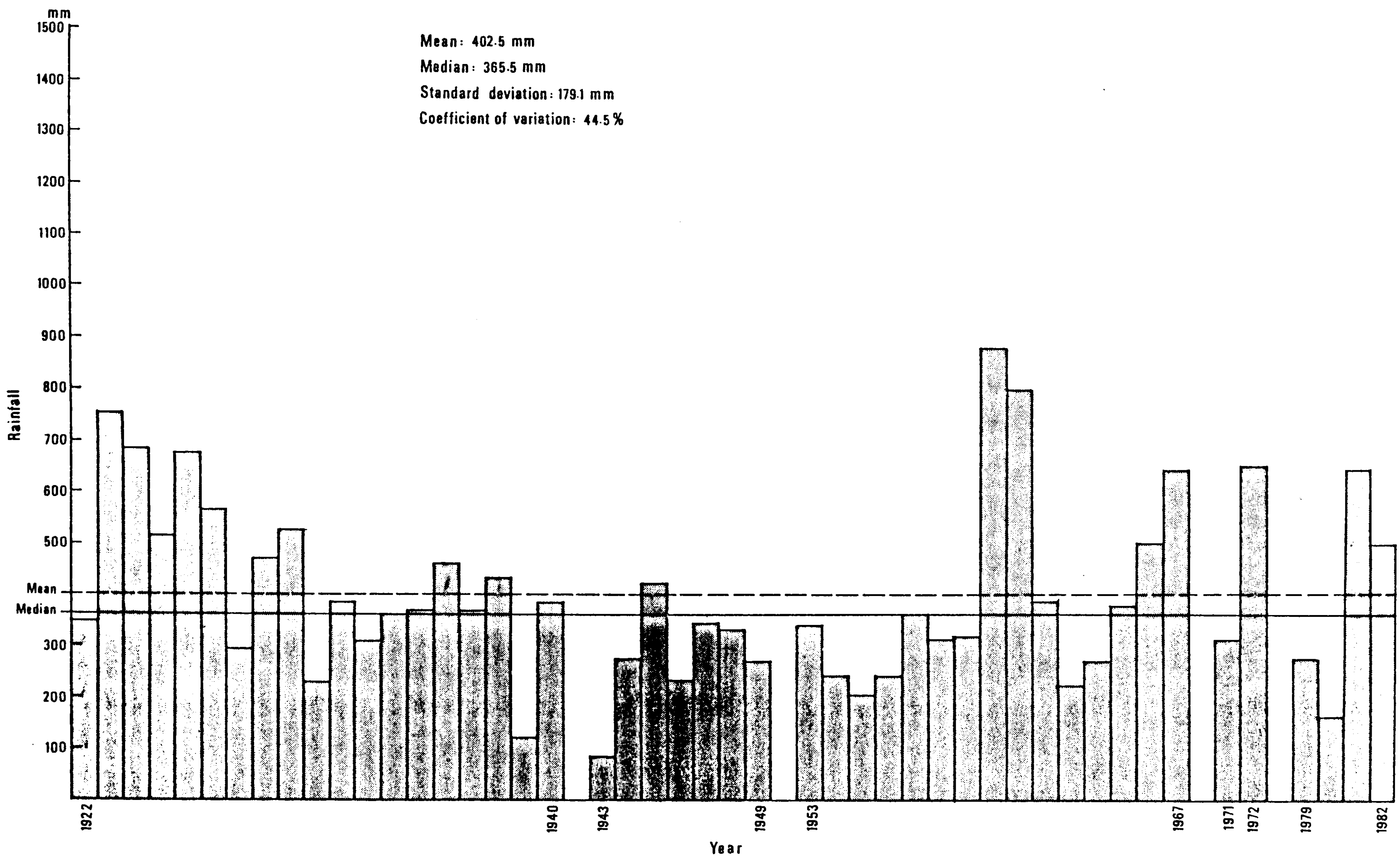


Figure 8.5: Annual rainfall totals for Afgoye station.

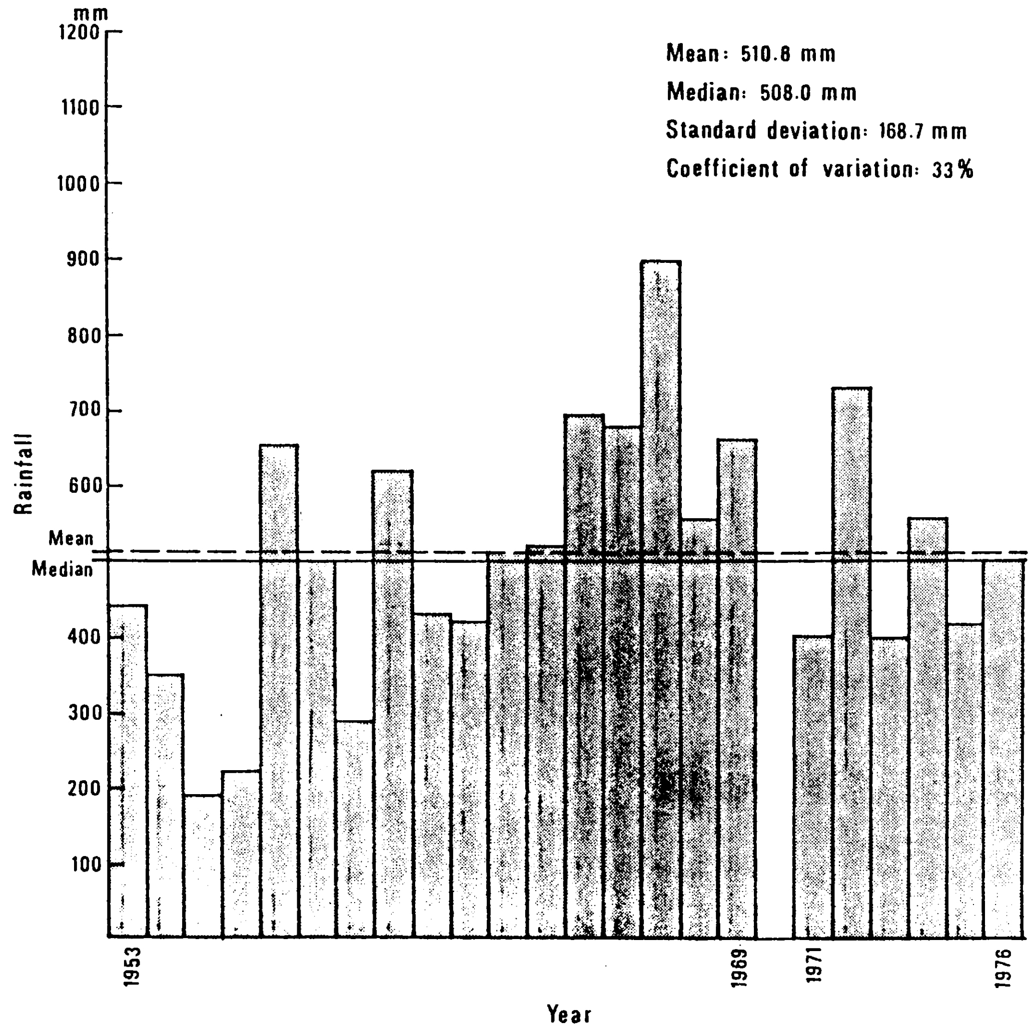


Table **8.2** Annual rainfall variability characteristics for Bardeera station (outside Bay region).

Periods	No of years observation	Median (mm)	Mean (mm)	Standard deviation (mm)	Coefficient of variation (%)	Lowest rainfall (mm)	Highest rainfall (mm)
1922 - 1926	5	675.3	596.9	162.9	27.3	351.7	757.0
1927 - 1931	5	470.5	417.9	146.2	35.0	231.0	566.0
1932 - 1936	5	366.2	377.8	55.1	14.5	310.5	462.3
1937 - 1940	4	379.3	327.7	142.0	43.3	118.5	433.5
1943 - 1947	5	344.8	272.6	172.0	46.6	85.1	422.5
1948 - 1949	2	300.9	300.9	44.4	14.8	269.5	332.3
1953 - 1957	5	243.1	273.9	70.2	25.2	202.7	365.5
1958 - 1962	5	388.6	538.5	276.1	51.3	313.4	377.9
1963 - 1967	5	384.3	405.9	171.8	42.3	224.0	646.6
1971 - 1972	2	483.9	483.9	237.1	49.0	316.2	651.5
1979 - 1982	4	389.3	397.6	217.4	54.7	163.7	648.3
Long - term	47	365.5	402.5	179.1	44.5	85.1	377.9

Source: Before 1960 computed from Fantolli (1965: 229); after 1960 computed from unpublished records of Meteorological Service, Civil Aviation Dept., Ministry of Land and Air Transport, Mogadishu, 1984.

Table **8.3** Annual rainfall variability characteristics for Afgoye station (outside Bay region).

Periods	No of years observation	Median (mm)	Mean (mm)	Standard deviation (mm)	Coefficient of variation (%)	Lowest rainfall (mm)	Highest rainfall (mm)
1953 - 1957	5	354.9	375.0	166.1	44.3	195.7	655.8
1958 - 1962	5	437.7	457.6	107.2	23.4	297.4	625.9
1963 - 1967	5	680.0	644.0	164.6	25.6	426.0	902.4
1968 - 1969	2	609.6	609.6	50.9	8.4	558.7	660.5
1971 - 1976	6	465.3	506.6	117.0	23.1	422.5	732.5
Long - term	23	502.2	506.2	165.8	32.8	195.7	902.4

Source: Computed from unpublished records of Meteorological Service, Civil Aviation Dept., Ministry of Land and Air Transport, Mogadishu, 1984.

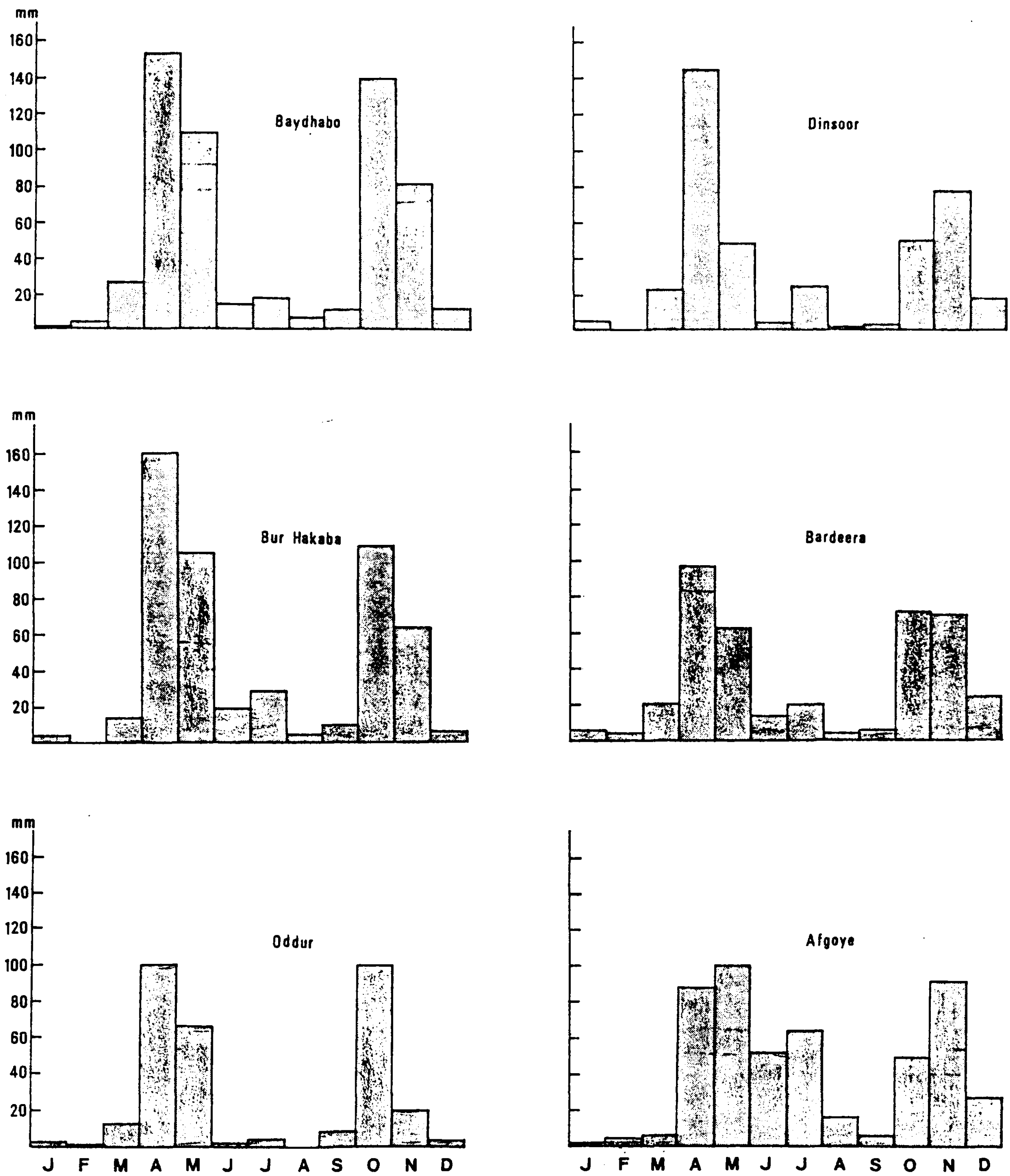
the differences between the lowest and the highest amounts of annual rainfall in each 5-year period show the fluctuating nature of rainfall over the short-term. As a consequence, the annual supply of forage, fuelwood and timber resources from the rangelands of Bay region and neighbouring areas is going to be susceptible to significant variations from one year to another, since the mean annual rainfall, within a short period, seems to be regular in its irregularity.

Finally, the short-term means as a percentage of the long-term mean appears to be very great. For example, at Baydhabo station (Table 8.1) the 5-year periods of 1922-1926, 1927-1931, 1932-1936, 1951-1955, 1956-1960, 1961-1965 and 1966-1970 show the following percentages: 133.9, 90.4, 89.0, 104.9, 94.6, 105.5 and 105.7. Four of the seven periods were wetter than the long-term mean, and three were drier. From this evidence, it would seem that there has been no marked change in the amounts of rainfall over the long-term(1922-1970), but that there are significant rainfall fluctuations between short-term periods. The percentages of the last two 4-year periods of 1971-1974 and 1978-1981 are respectively 71.1 and 110.1, and also show that it is short-term variability of rainfall as the drought of 1973-1975, rather than the long-term change of rainfall elements, which is the key element. At Bardeera station (Table 8.2), the percentages: 69.3, 133.8, 100.8 and 98.8 respectively of 1953-1957, 1958-1962, 1963-1967 and 1979-1982; as well as the percentages: 74.1, 90.4, 127.2 and 100.1 of 1953-1957, 1958-1962, 1963-1967 and 1971-1976 respectively at Afgoye station (Table 8.3), seem to offer further support for this view. This would, however, suggest that there is a reversible rainfall regime, and is not an indication of rainfall change. This is also found in other areas, such as the Sahelian zone, which is similar to the study area in terms of rainfall pattern (Landsberg, 1975). Thus, the findings of this study would appear to be in conflict with the opinion and perception of local people who insist that rainfall amounts are much less now than 20 years ago (see Appendix 2). This perception is largely unfounded, at least judging from the relatively short and discontinuous series of rainfall figures available for Bay and neighbouring regions.

Hemming (1966) attempted to link a reduction in rainfall in northern Somalia with an increase in temperature, as he had done in Aden, but his later effort in Somalia failed, owing to the short series of rainfall records, although the new reliable observations available at Djibouti do not confirm that change either. Nevertheless, the insufficiency of rainfall is a familiar pattern in Bay region's pastoral life, since the memories of local people suggest the occurrence of a series of droughts which have affected Bay region. It was reported during the 1984 field work, in addition to the data of University of Wyoming (Vol. 2, 1984) that drought years in Bay region occurred in 1900, 1906, 1909, 1922, 1933-34, 1936, 1943-1944, 1951, 1955, 1965, 1970, 1973-1975 and 1980. The occurrence of these drought years coincide with the recorded occurrence of drought conditions in Somalia, as discussed in Chapter One, and as such, Bay region is affected by at least one drought every three or four years. These drought years were given local names, usually according to the severity of drought. The droughts of 1922 and 1933-1934 were named joonki, meaning 'year of thirst'; the droughts of 1936, 1944 and 1951 were called tugaay meaning 'year of stealing', as, because of food shortages many people resorted to stealing animals; the drought of 1965 was named baasto, meaning 'year of pasta', when much pasta was imported due to the shortage of sorghum; the droughts of 1943 and 1970 were called busti, meaning 'year of dust', when dust was blown over some parts of the region's land; and the drought of 1973-1975 was abaar dabadheer, meaning 'the long-tailed drought'. In addition, some drought years were named according to the behaviour of people, as in the drought of 1900, which was called kordowra, when people looked up at the sky for rain but none came; and the drought of 1906, which was named yururi when people only sat because there was nothing to do . The fact is that drought is not only a familiar pattern to the Bay region's pastoral life, but it is also a structural feature of the region's economy. A structural response, for example, is that more than one type of grazing animal is often kept to spread risk, and a considerable amount of sorghum is usually stored by the local inhabitants, in order to protect themselves from the threats of drought. These facts help to confirm that the abnormality in rainfall is a part of the normal climate of Bay region, and the local people accept that and plan for shortages and annual variations in the supply of range forage, fuelwood and timber.

The distribution of mean monthly rainfall is also variable (Figure 8.6). For example, at Baydahbo in March, the mean value is 27 mm of rainfall while it rises to 153 mm in the following month (April), about 6 times the mean value for March. The mean monthly then falls from about 110 mm of rainfall in May to the other extreme of 14.2 mm of rainfall in June. Nevertheless, the driest and wettest months are often February and April respectively. Consequently the year is divided into two dry seasons (Jilaal and Hagai) and two

Figure 8.6: Mean monthly rainfall at stations in Bay region and surrounding areas.



rainy seasons (Gu and Dayr). Figure 8.6 shows eight months of Jilaal and Haqai seasons, with low levels of rainfall being experienced. In these dry seasons, economic life in the rangelands becomes difficult, with no cultivation possible on the arable lands, and much greater dependence on the reliability of watering points, wells, large waro and springs for drinking by humans and animals. In fact, these watering points become centres of great activity in the dry months for both selling food and giving veterinary care. In addition, most camel and cattle herds are driven south to the riverine areas, where they can be more easily fed and watered, while smallstock, and some milch cows and burden camels, are left at the homestead to be grazed on what is left of the sorghum stubble in the harvested fields as well as on fallen leaves in the nearby range areas.

Figure 8.6 shows, on the other hand, four months of Gu and Dayr seasons with mean monthly rainfall figures of between 60 mm and 140 mm enough for a good yield of sorghum. As it is, sorghum can be grown with an average seasonal rainfall, over 2 - 3 successive months, of less than 300 mm and, in some cases, with less than 200 mm, although yields may be proportionately reduced. It has, in fact, been suggested that drought-resistant cereals are being grown with only 100 - 125 mm of rainfall available (Grigg, 1970). The Gu season is considered as the main growing period in Bay region, since it accounts for about 45 per cent of the mean annual rainfall at Baydhabo. Estimations confirm this; for example, production of sorghum in the Gu season is about 350 kg per hectare compared with only about 250 kg per hectare in Dayr season (HTS, Vol. 1, 1982). In addition, crop production mostly depends on the amount of rainfall at the beginning of each rainy season, this being April in the Gu season, with about 60 per cent of the mean seasonal rainfall, and October in the Dayr season, with about 63 per cent of the mean seasonal rainfall. This is essential for the success of dry-farming, where the cultivated lands are left unused for several successive months of the Jilaal and Haqai dry seasons. It is, however, hard to predict the amount of rain likely to fall in April and October. For example, at Baydhabo, April had only 46.6 per cent of the mean rainfall of the Gu season during the 5-year period from 1956-1960, whilst October had only 32.6 per cent of the mean rainfall of the Dayr season during the 5-year period 1961-1965. The date of the onset of the Gu and Dayr seasons is also crucial for crop production, although it is equally hard to predict the start of each rainy season. It has been reported that the start ofthe Gu rains at Baydhabo varies between the 1st and 17th of April with an average of 9th of April (HTS, Vol. 1, 1982), but it was recorded during the 1984 field work that the rains of the Gu season in that year started earlier during the last days of March. In the Dayr season, the start of rains ranges from the 2nd to the 18th of October with an average at 10th of October (HTS, Vol. 1, 1982). These characteristics clearly have important implications for pastoral activities. For example, the extent, quality and availability of grazing land is affected when there is a delay of a week or two to the start of the rainy season. This can quickly lead to increased animal mortality rates as both range forage and drinking water are already in serious short supply at the end of dry season. Critical decisions have to be made, on the basis of incomplete information, about the condition of livestock, and whether to sell or slaughter, as discussed in Chapter Four.

The annual values of mean monthly rainfall are also highly variable from one 5-year period to another in Bay region and the surrounding areas (Appendices 8, 9 and 10). The variability is found in both months of the lowest and the heaviest rainfall. For example, at Baydhabo the mean monthly values in February over the 10 time-periods vary between 0.0 mm and 14.2 mm, with a mean of 4.8 mm, whilst, in April, the values vary between 141.4 mm, and 189.5 mm, with a mean of 153.0 mm. At Bardeera, the mean values for February for the 9 4-and5-year periods available range between 0.0 and 21.3 mm, with a mean of 5.1 mm, whilst the values in April, range between 56.2 and 160.0 mm, with a mean of 97.3 mm. Clearly, there is no marked consistent minimum limit in the mean monthly rainfall, even in the wet months. Taken as a percentage of the long-term monthly mean at Baydhabo, the 10 4-or5-year periods rainfall means for February are 170.8, 93.7, 14.6, 166.7, 295.8, 41.7, 25.0, 147.9, 16.7 and 0.0 per cent. In April, the equivalent percentages are 92.4, 74.6, 123.9, 108.4, 109.7, 83.8, 108.8, 97.6, 80.9 and 123.7 per cent. Indeed, mean monthly rainfall figures fluctuate significantly from one period to another, and this pattern is reflected by calculating the standard deviation values which are generally exaggerated by some heavy isolated rainstorms. These values are strangely higher than the mean values, especially in those months with the lowest rainfall. For example, the standard deviation values for February at Baydhabo are 13.9, 6.0, 1.1, 16.0, 27.4, 2.9, 1.8, 11.5, 1.6 and 0.0 mm of rainfall. This is due to the customary absence of rainfall in such months.

The variations in the mean monthly values are confirmed by calculating the coefficient of variation values. These values are generally more than 100 per cent in the months with the lowest rainfall, owing to the wide variations in rainfall amounts at a time when the mean values are low in any case. However, the changes in mean monthly rainfall between periods have a marked effect on the agricultural practices in Bay region. The use of simple crop management can also be related to the unreliable seasonal amount of rainfall, since any reduction in the amount of rainfall can lead to the failure of crops.

The results so far have shown that although there appears to be no evidence supporting a general trend towards the occurrence of less rainfall in Bay region, the annual and seasonal amounts of rainfall are nevertheless unreliable and highly variable. It appears that significant reductions in annual rainfall may be only a minor indication of land-use changes in Bay region. Nevertheless, an indication of rainfall predictions in both the long and the short terms may be significant. Two inferential methods are used: firstly, the observed rainfall distribution, which is calculated as shown below:

(i) The total number of 47 annual observations for Baydhabo station, for example, showing annual rainfall values, are ranked.

(ii) The expected number of years (for example 1 in 4 years) is multiplied by the total number of ranked observations, and the result, 11.75, is subtracted from the total number of ranked observations (47). The final result is 35.25 which is the new rank for the expected years. But, the table of ranks does not show the annual rainfall value for rank 35.25. This is calculated as the difference between rainfall values of rank 35 and 36.

(iii) The annual rainfall values of rank 35 and 36 are 720.8 and 725.9 mm respectively, with a difference between them of 5.1 mm. To obtain the rainfall value of the 35.25 rank, the difference of 5.1 mm is multiplied by 0.25 rank, which equals 1.275 mm. Thus, rank 35.25 equals 720.8 + 1.275= 722.1 mm of rainfall as shown in Table 8.4, under column of rainfall predictions derived from observed distribution.

The second method involves obtaining the normal rainfall distribution by the formula:

$$X = \bar{X} \pm ZS$$

where: X = required raw rainfall value;
$\bar{X}$ = mean rainfall value;
Z = critical Z value for selected limits; and
S = standard deviation.

Table 8.4 shows the rainfall probabilities according to the above two methods. In this case, rainfall predictions, which are calculated from observed rainfall distribution, are more useful than the rainfall values which are produced from normal rainfall distribution, since the annual rainfall values in these areas are frequently skewed. Thus, in 1 out of 4 years more than 722.1 mm of rainfall would be expected at Baydhabo station (Figure 8.7), while 383 mm of rainfall is the minimum expected in 3 out of 4 years. Once again, at Bardeera station, which also has long-term records, more than 499.6 mm of rainfall would be expected in 1 out of 4 years, whilst 277.1 mm of rainfall is the minimum expected in 3 out of 4 years (Figure 8.8). Such probabilities are helpful in trying to predict the annual amount of range

Figure 8.7: Rainfall predictions derived from observed distribution at Baydhabo station.

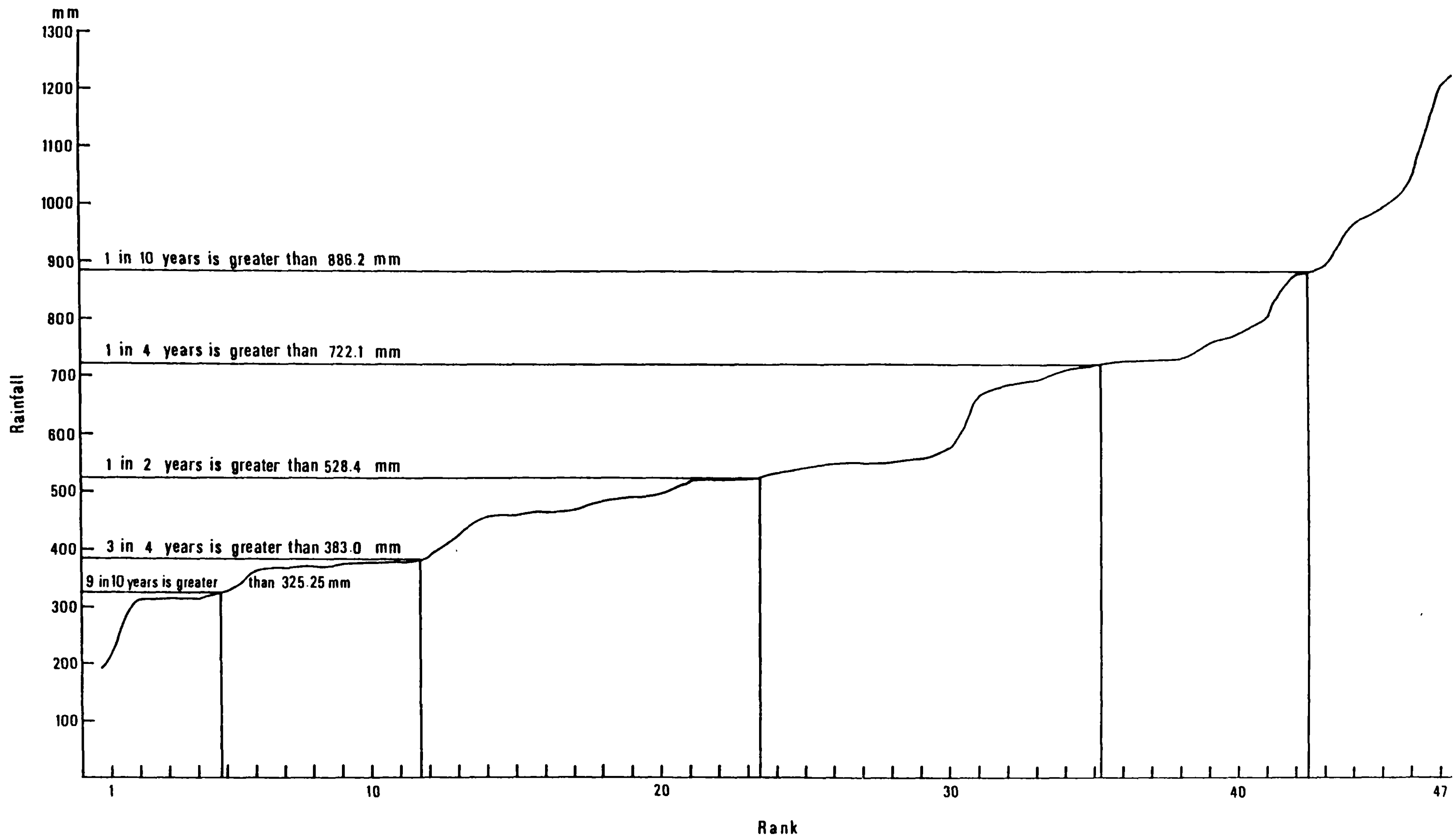
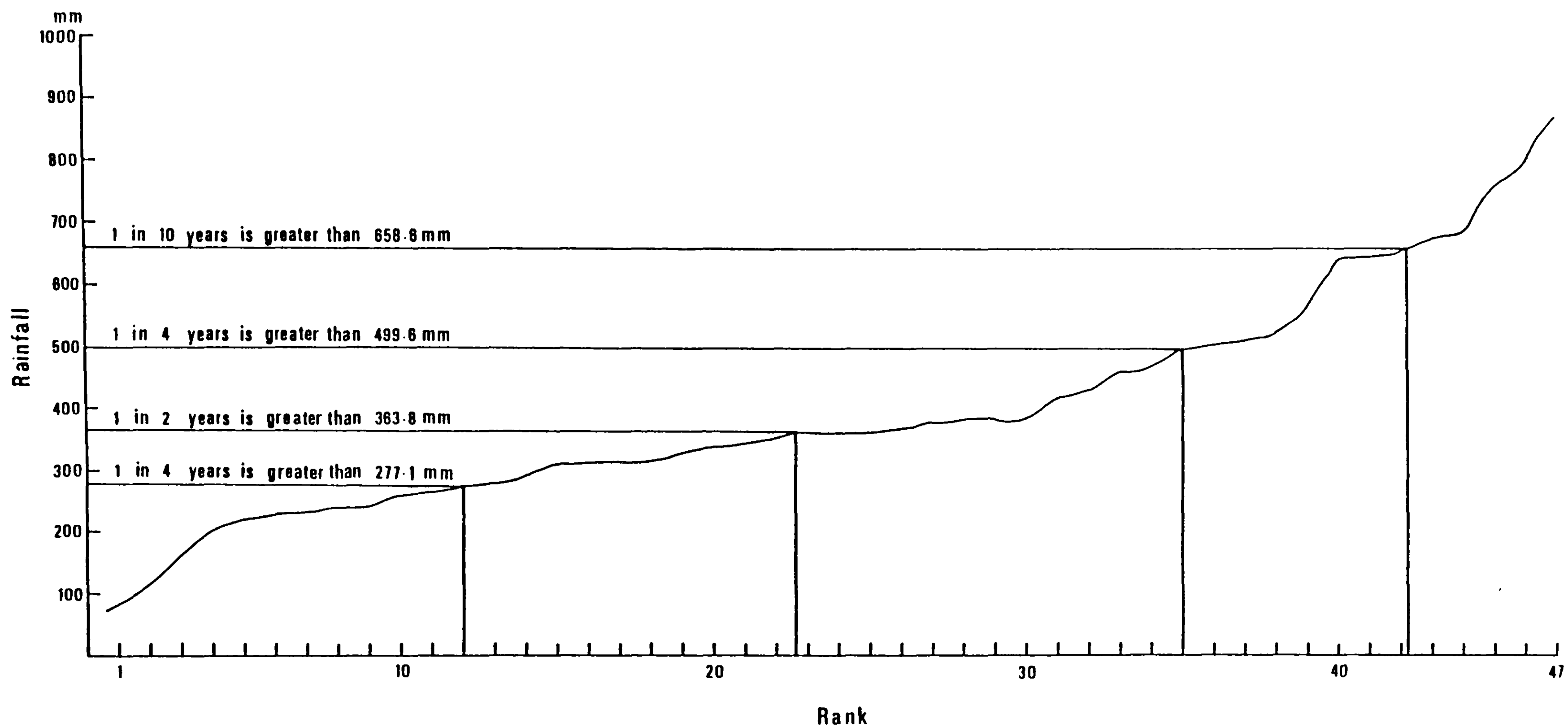


Figure 8.8: Rainfall predictions derived from observed distribution at Bardeera station.



forage likely to be available at various probability levels in Bay region.

Table 8.4 Annual rainfall probability characteristics (in mm) for long-term records at the three stations in and outside Bay region.

Rainfall probability		stations					
Years	%	Baydhabo		Bardeera		Afgoy	
		(A)	(B)	(A)	(B)	(A)	(B)
9-10	90	325.3	297.1	228.4	189.4	247.8	293.0
4- 5	80	379.1	395.9	233.3	250.8	384.1	368.9
3- 4	75	383.0	431.1	240.9	272.7	406.6	395.9
1- 2	50	528.4	580.5	324.1	365.4	505.1	510.6
1- 4	25	722.1	729.9	458.7	458.2	633.4	625.3
1- 5	20	728.4	765.1	482.8	480.0	657.7	652.3
1-10	10	886.2	863.9	535.7	541.4	692.6	728.2

(A)Rainfall predications derived from observed distribution.
(B)Rainfall predications calculated from normal distribution.
Source: Computed from the crude records of Fantolli (1965) and unpublished data in the Meteorological Service, Civil Aviation Depertment, Ministry of Land and Air Transport, Mogadishu.

8.2 Vegetation

Changes in the distribution of vegetation is a second environmental factor which contributes to an explanation of land-use changes in Bay region. Woody species, in the form of shrubs, bushes and trees, constitute the bulk of range cover in Bay region (see Section 2.1). This cover is consistent with exploitation by browsing animals such as camels and goats. This is because its non-herbaceous composition typically constitutes the bulk of the diet of camels and goats, rather than that of other animal types like cattle. Field (1980) has estimated that between 60 and 70 per cent of the diet of camels and goats in Somalia is obtained from these non-herbaceous species in contrast to the relatively low figures of 10 to 30 per cent for cattle and sheep. He also indicated that camels can physically obtain about one-half of their fodder requirements from dry matter available at heights of above two metres from the ground. Clearly the existing range vegetation cover of Bay region is not very appropriate for the raising of grazing animals such as cattle. Nevertheless, cattle numbers have risen by around 6 per cent per annum between 1975 and 1982. Further, there has been a shift in relative herd composition since the 1950s, from a reliance on camels and smallstock to an increasing reliance on cattle (see Chapter 4). This may be due to the increase in area under cultivation in the region, as this extension in cultivated areas has led to an increase in crop residues which can then be used to meet the fodder needs of the increasing number of cattle.

The fact is that the currently available range forage in Bay region would not appear to be of sufficient quality to support the present population of livestock. The total area of the region is about 4 million hectares and, assuming that almost all this territory is used as pastureland, this implies that there were about 5.9 hectares of pasture available per livestock unit in 1975. By 1982, this had been reduced to 4.8 hectares per livestock unit, reflecting the increase in livestock numbers which occurred during this 7-

year period (see Chapter 4). These stocking rates, however, show little significance unless they are related to the availablility of range forage. The availability of range forage in Bay region has been estimated to be about 557 kg of consumable dry matter (CDM) per hectare per year, assuming a mean annual rainfall of 500 mm (HTS, Vol. 1, 1982). This estimation is derived from the method used by Le Houerou and Hoste (1977), who applied it in the African Sahelo-Sudanian zones which resemble the rangeland ecosystems of Bay region. The consumable dry matter is obtained by the formula:

$$Y = 42.17 + 1.03\,\bar{X}$$

Where: Y = CDM production (kg/ha/year); and
$\bar{X}$ = mean annual rainfall.

Two extrapolations were indicated in the Le Houerou and Hoste study; firstly, most specialists on the Sahelian and Sudanian rangelands consider that only 40 per cent of the total primary production can be consumed in any one year, or the vegetation reserves will become exhausted. Secondly, this equation is not satisfactory, to the extent that when the rainfall is zero, one hectare can still appeerently produce 42.17 kg of consumable dry matter per annum. Le Houerou and Hoste (1977) have, therefore, tried in their study to establish a curvilinear relationship between range production and annual rainfall in the following equation:

$$Y = 1.057\,\bar{X}^{1.001}$$

where: Y = CDM production (kg/ha/year); and
$\bar{X}$ = mean annual rainfall.

This formula shows that one hectare affected, for example, by 500 mm of mean annual rainfall, will produce about 532 kg of consumable dry matter throughout the year, an estimation only a little different to the previously calculated figure from the Hunting report. The availability of consumable dry matter in Bay region is calculated for several conditions of annual rainfall, reflecting the fact that the rainfall regime in and around the region is irregular from one year to the next, and from one area to another as previously discussed. Therefore, assuming that most of Bay region's land is affected by 200, 250, 300, 350, 400, 450, 500, 550 or 600 mm of mean annual rainfall. Then, one hectare will respectively produce 212.5, 265.7, 318.9, 372.1, 425.3, 478.6, 531.8, 585.0 or 638.3 kg of consumable dry matter per annum. This implies that the total amount of consumable dry matter in Bay region can be estimated at 0.85, 1.06, 1.28, 1.49, 1.70, 1.91, 2.13, 2.34 or 2.55 million tonnes per year (Table 8.5), depending on the level of rainfall in any one particular year.

Table 8.5 <u>Relationship between the annual rainfall probabilities and the annual amount of consumable dry matter in Bay region</u>.

Annual rainfall probability	Consumable dry matter (kg/ha/year)	Total Consumable dry matter/year (million tonnes)	Actual livestock units
200	212.5	0.85	369565
250	265.7	1.06	460869
300	318.9	1.28	556521
350	372.1	1.49	647826
400	425.3	1.70	739130
450	478.6	1.91	830434
500	531.8	2.13	926086
550	585.0	2.34	1017391
600	638.3	2.55	1108695

The demand for range forage, on the other hand, is related to the total livestock units. Each livestock unit equals a mature cow of 250 kg weight, consuming 2.300 tonnes of dry matter per year (Le Houerou and Hoste, 1977). Consequently, the livestock units of 681,460 in 1975 require about 1.57 million tonnes of dry matter per year, while 1.91 million tonnes per year are necessary to feed 828,622 livestock units of 1982. Clearly, to supply the dietary needs of 681,460 livestock units in 1975, an annual rainfall of 350-400 mm in the region would be needed. For the 828,622 livestock units of 1982, an annual rainfall of 450 mm would be needed. In general, it can be seen that the necessary consumable dry matter, according to the dietary needs of the total number of 1982 livestock units, is insufficient to meet the needs of livestock, since most of Bay region can expect an annual rainfall of around 400 mm, producing an avearge of 1.70 million tonnes of dry matter to be consumed annually. It should also be noted that the overall average of consumable dry matter estimations for the nine annual rainfall probabilities (Table 8.5) show a clear shortfall of supply for about 0.21 million of the 1982 livestock units. Thus, the livestock put a considerable pressure on the range forage by consumming a high proportion of dry matter. In other words, livestock utilize more than 40 per cent of the total primary production of dry matter which of course, exhausts the plant reserves as mentioned above.

Grazing pressure grows constantly, owing to the number of livestock growing at about 3 per cent per annum in terms of livestock units (see Chapter 4). In this rate, demand for range forage increases automatically each year at an average of 48,000 tonnes, causing, therefore, persistent depletion of the range cover, unless an increase in rainfall to at least 500 mm takes place. An annual rainfall of 500 mm and more rarely happens in Bay region, or areas around, since the probability of this rainfall pattern is estimated to be 50 per cent and less (see Table 8.4). Consequently, the region's vegetation is at present under considerable pressure from local livestock, as range forage supplies about 75 per cent of the animal requirements per annum (HTS, Vol. 1, 1982). In addition, neighbouring herds also put extra pressure on the vegetation resources of Bay region, since their journey to the south during the dry seasons, and back to the north during the rainy seasons, passes through the region. The overall effect of overstocking is reflected in the decline of palatable species in many parts of the study area, as elsewhere in Somalia (Hartley et al., 1967).

It was reported during the 1984 field work by local inhabitants that they were well aware of the decline of palatable plants, especially among those herbaceous species which are mostly preferred by cattle. Many plant names were collected over different parts of the region, but it was difficult to identify most of them, even though they were compared with the available plant inventory of the Hunting report (HTS, Vol. 2, 1982) for Bay region alone, and Hemming (1971) for Somalia as a whole (for example jebin(Tetrapogon cenchriformis), dorar (Paspalidium desertorum), daremo (Chrysopogon plumosus), humba siib(Schoenfeldia transiens), mokway (Dignathia spp.), habgi, saydbin, maariea, hurbule, markura, dboloon, dhurbi, hindow and saydhabo). According to the 1982 Hunting survey (HTS, Vol. 1, 1982), it was also reported that most range vegetation in Bay region had poor grazing prospects because of overgrazing. Balanbaal (Abutilon figarianum), nigo figiis (Mundulea sericea), galaaliyo (Euphorbia grandicormis) and dharkeen (Euphorbia robecchii) are just some of the overgrazed plants mentioned in the Hunting report. Thus, the stocking rate, which is far beyond the carrying capacity of the rangelands, has induced overgrazing and, as such, vegetation by itself is a minor explanation of land-use changes in Bay region. However, too many poorly-managed livestock have contributed to a marked change in the structure of vegetation as evident in the disappearance of palatable species leaving unpalatable plants to dominate over an increasingly wider area of rangelands. This is not necessary that the overgrazing conditions are same over all the region. These conditions might be greater around the pastoral settlements and watering points owing to the continuous concentrations of grazing practices.

8.3 Soil

The third environmental factor helping to explain land-use change is that of soil. The four main types of soil in Bay region (viz: Vertisols, Regosols, Solonetz and Latosols (see Chapter 2)) are relatively low in fertility, although Vertisols possess higher capacity to produce crops than the other types of soils. These soils need to be assessed not only in terms of their fertility, but also in terms of their capability of withstanding changes in land-use. Decline in soil fertility, for example, occurs when rain-fed cultivation is attempted, due mainly to the fact that the soil is successively cultivated in the *Gu* and *Dayr* seasons, although soil moisture may be a serious limiting factor for such farming. Continuous cultivation, without replenishing fertility, deprives the soil of the necessary nutrients and moisture required for cropping, whereas the soil becomes overgrown with weeds which usually thrive in soils of poor nutrient and moisture contents, as indicated by Donahue *et al*. (1971), Kalpage (1976) and Tivy and O'Hare (1983). Locally, different farming techniques are used to minimise moisture loss and to improve soil productivity. The *Kawaawi* system divides the farm land into a series of small square-shaped basins in order to retain rainwater (see Chapter 5). Nevertheless, this is used only on a very limited scale, usually only on the smaller farms, because at the time that the system should be implemented, labour shortages are in evidence, due to the absence of herdsmen still tending the herds far away from their own farm lands. Those members who are still at home find themselves not only short of family labour hands, but also unable to pay hired workers. Weeding is also practised as another way of improving soil productivity, but it is not particularl efficient as the roots are frequently left in the ground (see Chapter 5). Consequently, valuable moisture and nutrients are lost or not fully exploited in each growing season. Crop residues, which add soluble nitrogenous fertilizer to the soil, are another method of improving soil productivity (Kalpage, 1976). This does not work very well in the study area, since the livestock soon clear up any remaining crop stubble in the farms. Further, the use of chemical fertilizers to improve soil productivity is often restricted in an environment with uncertain rainfall conditions, like Bay region, as fertilizers can become harmful to the plants if they remain undissolved through lack of showers (Grigg, 1970; Pratt and Gwynne, 1977). Animal dung, as a possible means of improving soil fertility, is undesirable among the agro-pastoralists of the study area, as it considered unclean and improper to handle animal dung. Nevertheless, animals grazing on the crop residues in the farms inevitably leave some dung which represents the only supply of manure to the cultivated soils.

The results of the 1984 questionnaire survey show that pastoral households are generally aware of changes in soil fertility over the past 20 years (see Chapter 7), but they believe that shortfalls in rain are the main reason for this problem, and not their own farming practices. However, this claim is not entirely accurate, since no significant changes in the rainfall regime of Bay region and surrounding areas have been established (see Section 8.1). The main reason for increased soil infertility is that land has been used more frequently for cultivation, even though unimproved farming methods are still employed (see Chapter 5). Therefore, such soil conditions result in the reduction of crop productivity, but it must not be assumed that the decrease in crop yield is due only to the reduction of soil fertility, since many other problems, such as birds, can give rise to poor yields (see Chapter 5). Thus, it can be concluded that reduced soil fertility can easily be produced by excessive human pressure. In other words, the cultivated soil is too frequently treated as permanent resource by agro-pastoralists in Bay region, and continuous cultivation is exacerbated by other factors, such as uncertain rainfall and primitive farming systems. Under such circumstances, the soil can only remain productive if it is cultivated in alternate years, in order to allow sufficient time for moisture to accumulate in the fallow year. In addition, the farm must be kept weedless so as to maintain productivity levels (Fitzpatrick, 1980).

Soil erosion is also reported in Bay region, occuring most frequently on those areas that have been exposed to overgrazing, overcultivation or overcutting of woody species. It was observed, during the Jilaal survey of the 1984 field work, that wind erosion mostly took place on the land bare of vegetation around pastoral settlements and watering points, and on the dry-farming lands themselves. In these areas, loose soil is easily blown away by the wind, especially when the trampling action of human feet, of animal hooves and of motor vehicles take places on those surfaces. It was also observed during the Gu survey of the 1984 field work that water erosion was most serious on these same overcultivated and overgrazed lands. In these areas, the soils are very susceptible to sheet and gully erosion. According to Young (1976), Whiteman (1980), Tivy and O'Hare (1985) and Goudie (1986), this phenomenon can be explained by two factors: firstly, unsatisfactory farming methods, such as continuous cultivation, cause a rapid depletion in organic matter content of soils. Hence, soil resistance to the process of water erosion is lowered because organic matter is necessary for binding the soil particles together. Secondly, overgrazing causes the removal of ground cover which protects the soil from rainwater run-off, thereby exposing the soil to the process of water erosion, as evident on the Latosols (see Chapter 2). It is clear that human actions play a major role in accelerating these erosion processes. Indeed, these erosion processes have become much worse in the last 20 years, as human pressures on the rangeland ecosystems have increased. The increase in soil erosion rate over that period has been confirmed by the local inhabitants, according to the results of the 1984 questionnaire survey (see Chapter 7). This also coincides with the growth in the livestock population of Bay region, especially cattle, with the consequent overgrazing of the herbaceous cover and overcutting of the woody plants, exposing the soil to increased erosion process. Further, the extension in the area of cultivated land, together with the use of primitive farming techniques have also contributed to the acceleration of the erosion process.

Over the 12-year period from 1973 to 1985, an attempt was made to measure the erosion process by using the available Landsat MSS images. These Landsat images cover part of Bay region, showing some drainage channels (see Figure 5.1), but it was not possible to delimit the eroded area on MSS imagery because of poor resolution. Nevertheless, the soils of Bay region have reached a critical situation of low fertility and high vulnerability to erosion processes. These regrettable results signal the beginning of the desertification process, and this process may worsen, since no serious procedures have been adopted locally to reduce the effect of overgrazing, overcultivation and overcutting of woody plants. Thus, changing soil conditions are also an indication of land-use change in Bay region, with the influence of humans on the quality of range resources (especially vegetation and soil through their grazing, farming and wood collection practices) leading to significant negative changes in the fertility, structure and erosion rates of the soils.

8.4 Summary

This chapter is focused on environmental factors as an explanation of land-use in Bay region. Meteorological observations and the recollections of local inhabitants suggest that there exist short-term fluctuations of rainfall, rather than long-term changes. Nevertheless, these fluctuations set limits on the biological activity of the rangelands. The fact is that the environmental resources of Bay region are highly vulnerable, especially when greater pressures from grazing and other land-use activities are placed on the rangeland ecosystems. The increase in grazing, dry-farming and wood collection practices can easily reduce the productivity of rangelands. Thus, this might suggest that the human pressures on the rangeland ecosystems are rather more at fault, than the environmental factors themselves, for the poor supply of range forage, decreased soil fertility, reduced woody plants and increased soil erosion over the past 20 years. Pressures on the rangeland ecosystems are dealt with in the next two chapters.

CHAPTER NINE

TECHNOLOGICAL AND ECONOMIC FACTORS

9.1 Introduction

From the discussion so far, changes in land-use in Bay region appear to be partly explained by the direct influences of environmental factors. Technological, economic and socio-political factors may offer futher explanations of land-use changes over the past 20 years. This chapter discusses the effect of technological and economic factors, and includes: water supply, veterinary services, livestock sales and slaughter, farming practices and wood collection. Chapter Ten focuses on the effect of socio-political factors.

9.2 Water Supply

Water supplies in the rangelands of Bay region have increased during the last two decades, mainly through the sinking of a large number of wells and the establishment of many *waro*. This increase was confirmed by the local inhabitants. In addition, the 1973 and 1982 estimations, contained in the technical report of HTS (Vol. 2, 1982), which appear to be reliable, show that the number of wells has increased by about 162 per cent per year during the 9-year period from 1973-1982, whilst the number of *waro* has increased by about 34 per cent per annum during the same period. This increase implies that the density of wells per square kilometre has increased by a facter of 16, whilst that of *waro* by about 4 during that period. Nevertheless, these increases in the number of wells and *waro* do not mean that the entire area of rangelands in Bay region has been covered, since some range areas, such as the central part of the region, show a higher than average density of water points per square kilometre (see Figure 2.4). However, the increased number of watering points has had important negative ecological consequences by making more range areas in Bay region accessible for livestock grazing during the dry seasons. Previously, these range areas were unsuitable for grazing in the dry seasons, because of the lack of water or, at best, they could only be used by the most hardy animals such as camels which can survive for longer periods without water (Sandford, 1983). Thus, the provision of new water supply points has given the less hardy animals, such as cattle, easier and more reliable access to the forage available in these newly-watered rangelands. In addition, the range forage of the newly opened rangelands contained many herbaceous species, because this type of vegetation had been only lightly grazed previously, since only camels used to browse in these areas. Consequently, as grazing pressures have increased, these species have disappeared, leaving only the more hardy and less nutritious species behind. The result of this combination of new, reliable water facilities and succulent range forage is that the herd structure has gradually altered from one of a predominance of camels and smallstock, to one of predominance cattle in the last few decades (see Chapter 4). The development of reliable water supplies is one of the key factors contributing to changes in herd composition in Bay region, as cattle can be kept with greater security than previously. As a consequence, the number and geographic spread of pastoral movements have been gradually reduced, as increasingly longer periods are being spent by nomads and their livestock around watering places. The interrelationship between the increase in the number of cattle and the decrese in pastoral movements is significant at 0.01 level of confidence by using Chi-square statistic, according to the findings of the 1984 questionnaire survey (see Chapter 7). The combination of increased cattle numbers and reduced pastoral movements not only shows a tendency towards a more settled way of life, but also involves the constant use of a given area of range forage, especially the herbaceous species, with all the implications this has for land degradation. Thus, grazing pressures have increased markedly in the last two decades on the vegetation reserves close to the watering points, leading to a decline in the density of palatable plant species (see Section 8.2).

The availability of water is also affected by changes in the type of supply. For instance, during the last decade, 24 large waro have been constructed in the region. Each can store more than 20,000 cubic metres of rainwater,compared with the domestic war which has an average capacity of 800 cubic metres (see Chapter 2). Consequently, about 25 domestic waro contain the same amount of water as one large war. The main implication of this is that a large war waters a signifiantly larger number of livestock over a given time-period compared to the domestic war (Plate 9.1). Indeed, a large war can water one million head of cattle per day, whilst a domestic war can water 40 thousand head of cattle per day, based on an estimate of a mature head of cattle requirng about 20 litres of water daily (HTS, Vol. 3, 1983). Such heavy demands clearly expose the vegetation and soil in the surrounds of large waro to heavy concentrations of animal grazing and trampling, eventually leaving the watering areas, at the end of the dry seasons in a devastated condition. The existence of large waro,

Plate 9.1 Roughly 50 cattle can drink their fill at one time from one concrete trough. As such, a large war with eight troughs, waters a greater number of livestock than the domestic waro. This in turn leads to the heavy concentration of animal grazing and trampling on the nearby range areas.

therefore, can be extremely harmful to the rangeland ecosystems of Bay region, in spite of their importance as an essential source of drinking water for livestock in the dry seasons. The use of modern equipment, such as diesel-driven pumps, has also made for a considerable increase in the amount of water drawn in a given period, especially compared with more traditional ways of drawing water, such as by hand in a rubber bucket held by a length of rope. Consequently, more herds are kept close to those watering points with this modern technology, as it is much easier and quicker to water the animals during the dry seasons, although charges are imposed by the government for this service.

The improved availability of water supplies has led to the growth of pastoral settlements, a growth confirmed in the 1984 survey (Appendix 2). It is difficult, however, to conclude that this growth has resulted only from the increase in drinking water supplies, since other factors like the soil capacity to produce crops, improvements in the transport system, the growth of markets and the introduction of some social services (for example sedentary education facilities) have also had a positive effect on the growth of these settlements in the study area. The local inhabitants, in general, believe that this growth has mainly resulted from the increase of watering points, but the findings of the 1984 questionnaire survey do not show a significant interrelationship using Chi-square statistic, between these two variables (see Table 7.4). The links between the extra watering points and the growth of pastoral sedentarization are strong, since most of the pastoral settlements in Bay region are locally dependent, for at least part of the year, on the rainwater gathered in the <u>waro</u>, and, for the rest of the year, on the water available in wells and springs. In this case, places with permanent and improved water supplies may attract more people and animals to their area than those places with temporary and unimproved water supplies (Al-Awad et al., 1985). Such unplanned settlements can, therefore, involve as many people and their animals as possible, exceeding the carrying capacity of environmental resources in the nearby rangelands. In these areas, both vegetation removal and soil degradation have actually come about for the following reasons: firstly, the clearance of rangelands for the practice of dry-farming and the construction of housing; secondly, the constant collection of wood for cooking and building purposes; thirdly, the continuous effect of human and animal trampling; and finally, the concentrated pressure of animal grazing, especially by smallstock and cattle. Thus, the fragile ecological equilibrium has been disturbed by such concentration of people and livestock (Davies, 1986). This implies that the communual use of fragile rangelands is unable to accommodate the larger numbers of people and livestock for longer periods of time.

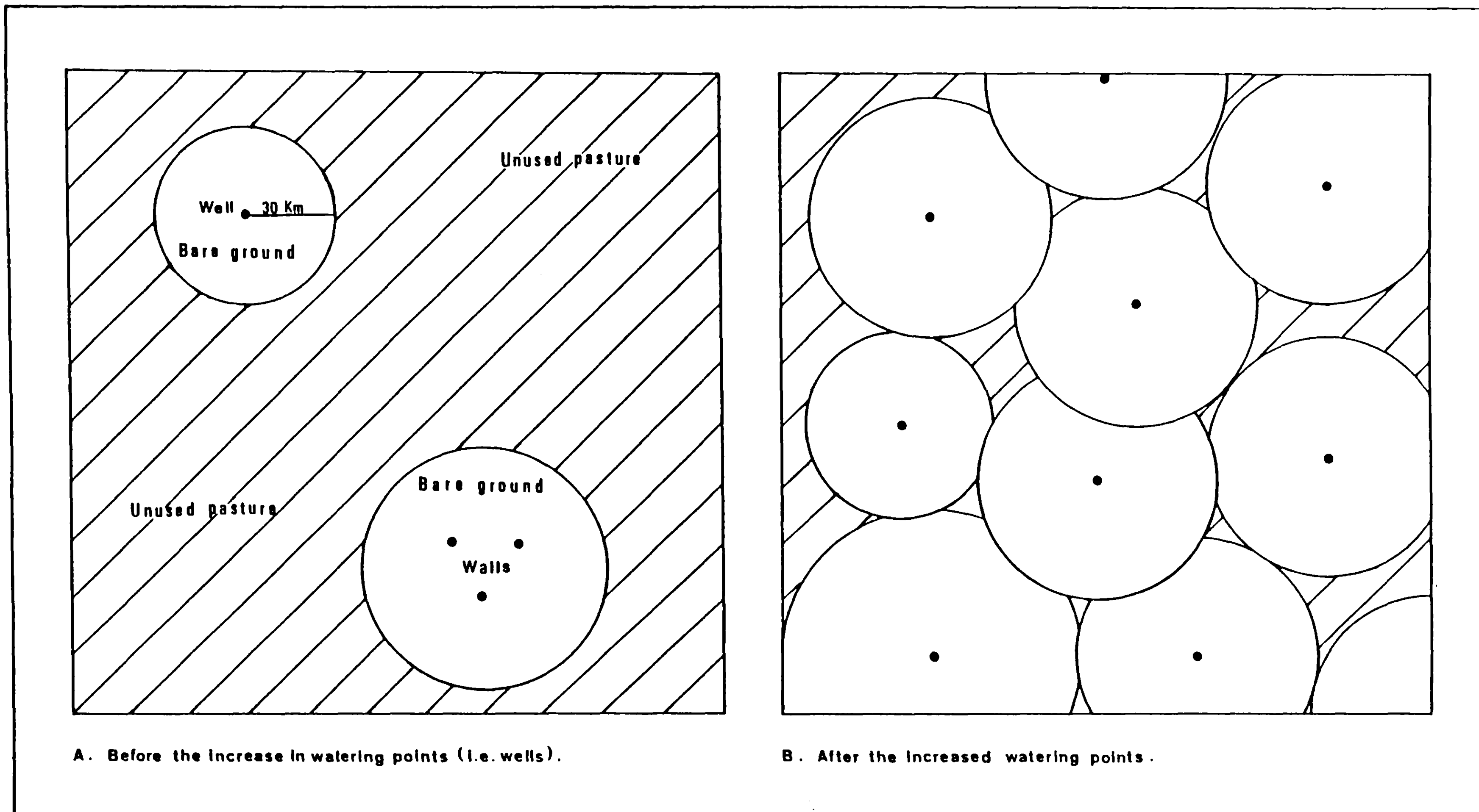
The overall picture is one where the spontaneous concentration of humans and animals have had a great impact on the local resources in Bay region. The range resources, especially in the vicinity of watering points have been overused and the ground, being left mostly bare, has been exposed to accelerating erosion processes, thus indicating the beginning of the process of desertification. The increase in the number of watering points in Bay region over the last two decades would appear to have led to the expansion of the desertification phenomenon over wide areas in Bay region, leaving very few intermediate rangelands unused (Figure 9.1). Consequently, pastoral ecosystems in Bay region are at great risk, especially during the dry periods, since desertification processes worsen during these times, in spite of the continuous supply of drinking water. The loss of animal stock during the Jilaal dry season of 1984 provides a good example of the destruction of the pastoral ecosystem, since the losses were primarily due to inadequate nutrition gained from what range grazing still existed.

9.3 Veterinary Care

Under government supervision over the last few decades, veterinary services in Bay region have been greatly improved, and this has been much appreciated by the local inhabitants (see Table 7.1). The, spread of contagious diseases has been much reduced through the vaccination of livestock against rinderpest, anthrax, foot and mouth disease, bovine and caprine pleuropneumonia, black-quarter and haemorrhagic septicaemia. This is done by travelling teams of veterinary staff, without any charge to the pastoralists as the vaccines are locally produced by the Serum and Vaccine Institute in Mogadishu. The purpose of this free service is to ensure the coopertion of livestock owners in checking the spread of these epizootic diseases. This policy has not only led to the increasing life expectancy of livestock, but also to an increase in the number of livestock, since the pastoralists no longer need to sell some of their animal stock in order to pay for the vaccination services (Holtzman, 1982).

Vaccinations are usually carried out in the dry seasons, because the livestock are easily accessible at this time of

Figure 9.1: Relation between the development of watering points (i. e. wells) and the spread of range deterioration (after Rapp, 1974).



year around the watering points. Consequently, relatively large numbers of grazing animals can be vaccinated within a short period time, without having to search for the animals over a vast area. These vaccinations are generally very effective, since the periods of vaccination (Jilaal and Hagai dry seasons) are when fodder is at its scarcest and, with less to feed on, livestock are in their weakest condition and are therefore more susceptible to these dangerous diseases. Clearly, this has saved the lives of a great number of animals. Nevertheless, the local people's perception of the effects of these diseases on their livestock in the past 20 years (see Table 7.1) show that only rinderpest is now well under control, while the other diseases have not been so effectively controlled. The reason is that rinderpest was combatted through a comprehensive plan of vaccination (Pan-African Rinderpest Control Project) in Somalia and other East African countries. This campaign was effectively carried out in Somalia between 1969 and 1975, and, according to the official reports of the Somali government, it was estimated that about 90 per cent of the Somali cattle had been vaccinated by the mid-1970s (State Planning Commission, 1979). The impressive results of this project were confirmed by the local inhabitants of Bay region, gaining a points-score of 77 per cent in the 1984 perception survey (see Table 7.1), but the interrelationship between the increased number of cattle and the decreased problem of rinderpest was insignificant using Chi-square statistic (see Table 7.2).

There would appear to be a relationship between the decline in rinderpest infection rates and increase in cattle numbers in Bay region, in that more cattle were now capable of surviving, following the success of the rinderpest vaccination campaign. This is reflected in the relative changes in the species composition of livestock in Bay region, from a reliance on camels and smallstock 20 years ago to a reliance on cattle now (Table 4.5). A further effect of the rinderpest vaccination campaign was that it was important in convincing importers abroad that Somali cattle were free of rinderpest, and this led to an increase of Somalia exports of cattle from about 36,000 annually in the 1960s to about 58,000 annually in the 1970s (Ministry of National Planning, 1982). However, in 1984 doubts about the state of health of cattle in Somalia, led to a reduction in the number of cattle exported in that year, according to government officials, although there were no figures to show the exact number of cattle which were actually exported. The cause of the controversy was the claim by the importers of Somali cattle in south-west Asia that the cattle in Somalia had been re-infected by rinderpest. This allegation was completely refuted by the Somali officers in the relevant departments, such as the Livestock Development Agency (LDA), although the findings of the 1984 questionnaire survey show that rinderpest is one of the problems still occuring among cattle at least in Bay region (see Chapter 4). This lends some credence to the claims of cattle importers in south-west Asia. This state of affairs is a serious threat to the economy of Bay region and, indeed, that of Somalia as a whole, because if the attack of rinderpest is not eradicated Somali cattle will no longer be in demand by importers abroad, such as those in Saudi Arabia. Since the export of cattle is one of the largest sources of foreign exchange earnings for Somalia, and as Saudi Arabia is the prime market for Somali cattle, accounting for 94 per cent of all Somali cattle exports in 1981 (CSD, 1983), this could have a crucial impact on the regional economy of Bay, as well as on the national economy of Somalia.

Treatment for endo- and ecto-parasites, such as trypanosomiasis, helminthiasis and tick-borne diseases, was given without cost during the 6-year period from 1970 to 1976, for demonstration purposes. Although this operation was carried out for only a few years, it contributed to a rise in the number of livestock, since more stock survived and the pastoralists were again not required to pay for such services and therefore they did not have to sell any of their stock. Since 1976, it has become necessary to charge the pastoralists for such treatments in order to cover the operational costs of drug importation. Informal discussions with the local people of Bay region during the 1984 field work showed that the livestock owners were in fact willing to pay for the drugs they needed to treat these diseases, but that the drugs were frequently unavailable in the local sections of veterinary care and mobile dispensaries. The veterinary officers in the departments of livestock health in Baydhabo and Mogadishu attributed the scarcity of the drugs to the irregular system of importing them from abroad by the Ministry of Livestock, Forestry and Range. Consequently, according to the local inhabitant's perception (see Table 7.1), the incidence of some parasites, especially tick-borne diseases, have increased in the past 20 years. This is despite all the efforts carried out by veterinary officials to treat these diseases by the dipping and spraying of infected animals. The main reason is because of the difficulty in controlling the vectors within the increased population of livestock; moreover, information on the occurrence and spread of ticks is insufficient. This is not merely in Bay region, but in Somalia as a whole (Holtzman, 1982). It is therefore expected that ticks will remain a serious problem for Somali livestock for the foreseeable future.

Conversely, tsetse-fly infestations in the study area have been reduced over the last 20 years, although the problem of trypanosomiasis (borne by tsetse-fly) has not been correspondingly reduced, at least according to the perceptions of local people (see Table 7.1). This is because only the north part of Bay region is free of tsetse-fly. Thus, when livestock return to Bay, particularly from the riverine lands to the south of Bay region, many of the cattle and camels are already infected with trypanosomiasis and bring it back with them to the study area.

The expanding scope of veterinary care in the study area has brought about a marked increase in the number of veterinary sections, staff and equipment over the last two decades. No statistics are available, however, to show what the situation was earlier, but these increases were confirmed by both the local people and the relevant officers in the veterinary sections interviewed over Bay region during the 1984 field work. The study area had, in 1984, four main animal dispensaries plus eleven sub-district branches as at Uforow, Yak Brawe, Dolandole, and also near the big livestock market in Baydhabo. There were nine mobile dispensaries and two mobile vaccination teams, besides the permanent sections. The total veterinary staff comprised 4 veterinarians, 17 assistants, 15 dispensers and 27 auxiliary workers. However, this has taken place gradually over the past 20 years, according to formal discussions with the relevant officials in Bay region. In spite of the positive changes in veterinary services, most of the common livestock epizootic and parasitic diseases still exist in the region.

This condition is attributed to, firstly, the still inadequate number of trained and experienced veterinary staff, in comparison to the large and continually growing numbers of livestock; secondly, the lack of detailed knowledge of the occurrence and economic significance of livestock diseases; thirdly, the insufficient and poor storage facilities for drugs and vaccines which often lead to their being unusable; fourthly, the shortage and poor quality of the available dispensing equipment; and finally, the logistical and accommodation problems encountered by the field staff. It is almost certain that livestock in the study area will still suffer from diseases, despite the govermental efforts, the evident improvements in the veterinary services and the high levels of cooperation between livestock owners and the veterinary staff to control animal diseases. The simple reason for this is that livestock is still raised under the pastoral system which makes the control or eradication of animal diseases quite difficult, if not impossible, owing to livestock movements from one place to another. As such, it is difficult to cover all grazing areas with the available veterinary supplies owing to the lack of accessible roads and tracks.

9.4 Livestock Sales and Slaughter

The loss of livestock caused by water shortages or by the outbreak of diseases has been significantly reduced over the last two decades (Sections 9.2 and 9.3). Consequently, pastoral households now have a greater potential for increasing the annual off-take from their animals. In particular, there has been a rise in the number of animals which are sold and/or slaughtered in a year from the surplus stock. The pastoral groups now have a higher sense of security against the risk of drought and epidemic outbreak of diseases, due to the increase in watering points and improvement in veterinary care. It is not easy to ascertain and thereby conclusively establish, the general trend in the local increase of animals sold and slaughterd in Bay region, nor for that matter in Somalia. There are insufficient official statistics, and those which are available, such as the number of slaughtered animals in the municipal abattoirs, are incomplete, as the data do not include domestic slaughter carried out by the local people. Nevertheless, the increase in animal sales and slaughter has been widely discerned by the livestock owners themselves, according to the findings of the 1984 questionnaire survey (see Table 7.1). The local increase of animals sold can only be established by using the available data of animals exported from Somalia during the 22-year period from the early 1960s to the early 1980s (Table 9.1). This table shows that the highest increases in livestock exports were of cattle, with the number of cattle exports in 1981 having increased about ninefold compared to the 1960 figure. Camels and smallstock exports grew rather more slowly; by 1981 the figure of each type exported was about twice what it was in 1960.

There are many factors behind the rapid growth of the Somali livestock trade in general and cattle trade in particular. These factors have been discussed by many authors like Konczacki (1978); Swift (1979); Holtzman (1982); and Reusse (1982). In general, these factors include: firstly, the increased purchasing power for live animals, mainly cattle in the regional markets of the Middle East, especially Saudi Arabia. This is aided by the large influx of foreign workers and technicians to those petroleum producing countries.

Table 9.1 Recorded exports of live animals from Somalia, 1955 to 1960-1981 (in thousands of heads).

Year	Cattle	Camels	Smallstock
1955	8.8	1.7	320.0
1960	12.4	6.3	574.5
1961	24.9	7.7	627.7
1962	31.5	10.4	747.4
1963	49.4	16.6	860.2
1964	56.6	17.1	1015.5
1965	38.1	24.1	791.6
1966	39.1	24.1	1097.7
1967	35.7	36.7	933.4
1968	41.6	17.0	1302.2
1969	34.3	25.3	1406.5
1970	45.0	26.0	1151.0
1971	59.0	26.0	1186.0
1972	81.0	22.0	1635.0
1973	68.0	29.0	1384.0
1974	31.0	24.0	1238.0
1975	40.0	34.0	1536.0
1976	58.0	33.0	766.0
1977	55.0	33.0	926.0
1978	77.0	22.0	1454.0
1979	68.0	13.0	1422.0
1980	93.0	17.0	1481.0
1981	116.0	14.0	1314.0

Sources: The 1955 to 1960-1965 figures are compiled from the Planning Commission (1968); The 1966-1969 figures are compiled from the Ministry of Planning and Co-ordination (1971); The 1970-1981 figures are compiled from the Ministry of National Planning (1982).

Secondly, since the 1960s three new deep water ports at Kismayo, Berbera and Mogadishu have been constructed. These new ports have brought about a great improvement in the shipping facilities and, as such, animals do not have to wait for excessively long periods on the quayside with the increased risk of death, as was the case previously. In addition, the provisions of veterinary care, water, and fodder to animals awaiting shipping at these ports have greatly contributed to the health of exported animals and reduced mortality rates. Finally, the increased number of watering points along the main export routes, as in Bay region (see Figures 2.4 and 4.2), have reduced the pressures of thirst and the attendant health problems on the animals which may have to trek for long distances before reaching the ports.

In spite of the visible overall increase in the number of livestock exports, there were considerable fluctuations in animal trading from one year to another (Table 9.1). Holtzman (1982), Reusse (1982) and Clark (1985) have given two reasons for this fluctuation. Firstly, there are droughts and their retarding effects on animal growth and fertility. This was evident in the drought of 1973 - 1975, which caused a marked decline in the reproduction rates of livestock, hence fewer animals were available for export in the following year. Secondly, the availability of shipping facilities and capacity for livestock varies and may often be inadequate, particularly during the peak periods of exports, such as during the Islamic pilgrimage season (haj). However, the growth of livestock marketing has not brought about a significant change in the basic orientation of animal husbandry, since the pastoral practices of animal raising in Bay region are still orientated towards subsistence stock-rearing, as shown in Chapter Four. The fact is that the increase in the number of animals exported has been largely a response to an increase in external demands for live animals, rather than as a result of improvements in the quality of livestock husbandry, in the form of increases in weight and quality of animals sold, or the improved regularity and reliability in fodder and water supplies.

This situation has some socio-economic consequences. Firstly, the social practice of keeping animals surplus to subsistence needs, for the purpose of alms (sadaquo) and loans (irman bariyeed) to those in the family lineage, has been affected by this boom in the number of animals sold. The result is that the number of animals kept for this social practice is now much less than it used to be, since most of them are now being sold. The overall consequence has been the weakening of social ties and hence of communal strategies of mutual support for members in times of crises like drought (Dahl and Hjort, 1976). Secondly, the increase in the sale of animals means higher cash incomes in the hands of the pastoral groups. Hence, there has been a marked shift from the dependence on livestock as a form of currency towards the greater use of cash. In other words, the pastoralists in Somalia have become much more reliant on the cash economy like other pastoral groups in East Africa (Strange, 1980c), leading to a higher cash purchasing power of the pastoral household. This situation has mostly resulted in an expansion of non-pastoral activities such as the growth in the number of small shops which sell the basic necessities of the pastoral household (salt, sugar, tea, cloth, soap, kerosene, matches and batteries), rather than in improvements in the quality of livestock-raising.

Finally, the relatively greater growth in cattle exports is a further explanation of the shifting species structure of livestock, from a reliance on camels and smallstock to cattle, as evident in Bay region (see Section 4.2). The interrelationship between the increase in cattle numbers and the growth in animal sales is significant at 0.05 level of confidence according to the findings of the 1984 questionnaire survey (see Table 7.4). Thus, export market requirements, especially in south-west Asia, have led to a change in the pastoral system of Bay region, from a dependence on a principally subsistence economy, in the form of camels and smallstock for household reproduction, to a much more market-oriented economy, in the form of cattle for sale and eventual export. The problem is that the rangelands in Bay region are not ecologically suited to the scale of increases in cattle raising in the area which this export demand has brought about (see Section 8.2).

The boom in animal sales and slaughter has not caused a reduction in the pressure of livestock on the rangeland resources, especially of range forage supply. Consequently, the rise in animal sales and slaughter has not accounted for the growth of livestock population in Bay region, mainly because livestock are still raised in the social context of households and their needs, indicating that the final decision to sell or slaughter the animal is taken by the pastoral households themselves. The timing and scale of animal sales are widely affected by family needs for cash, while animal slaughter is affected by the occurrence of religious and social functions, such as wedding feasts, or by the health condition of the animal being slaughtered (see Chapter 4). In other words, pastoral households' off-takes do not take into account the carrying capacity of the rangelands. Consequently, it is unlikely that increases in animal sales and slaughter will solve the problem of overgrazing in Bay region.

9.5 Farming Practices

There has been a significant increase in the area of dry farming lands over the past two decades in Bay region (see Section 5.1). This expansion is, however, not as a result of increased or abundant rainfall, since no marked change in the rainfall pattern is evident in the region or in the areas around (see Section 8.1). Local needs for cereal food, the establishment of agricultural co-operatives and increased agricultural services are the main factors behind the expansion of dry-farming lands. The issue of local needs for grain has mainly been related to increases in the population since the extension in cultivated areas implies an increase in crop production (see Section 5.1). Thus, an increase in crop land is the major means, beside the growth in livestock numbers, to meet the subsistence needs of the growing population.

Agricultural co-operatives (iskashato) are another factor to explain increased area of land under cultivation. These co-operatives are government-assisted, and provide two seasonal loans for farmers to correspond with the two cropping seasons of Gu and Dayr. Improved seeds, insecticides and other agricultural services are supplied free of charge, while the farm tractors are rented out when available. These facilities are supplied when agreement is reached between a group of farmers (about 20 members) and the relevant government agents in establishing the co-operative. The main advantage of this system is seen to be the increase in the area of cultivated lands, since new areas of land must be used in the co-operative farming. This is done in addition to maintaining the individual farm lands of members. This system of co-operative farming has, however, not been widespread among agro-pastoralists in Bay region, despite government encouragement and efforts since 1974. There are no reliable official data available to support this statement, but the findings of the 1984 questionnaire survey show that only 14 per cent of the surveyed agro-pastoral households were members of agricultural co-operatives. Moreover, most of these respondents were willing to end their participation in these co-operatives. The major cause of this state of affairs can be summarized as: firstly, there is a social problem posed by the lack of understanding of what this system really means on the part of the joint members. Internal disagreements have developed around the idea that the co-operative is not a personal farm, and this has led to a lack of interest and commitment of the part of many co-operative members. Secondly, the available loans are insufficient to cover co-operative expenditures; for example, the cost of renting a farm tractor is between 80 and 120 Somali Shillings per hour, and the tractor must be rented for at least 8 hours, including the travel times between the agricultural section and the farm. As such, about a quarter of the total seasonal loan is paid out in renting a tractor for only 8 hours. The problem of limited loans is often attributed to the fears that these loans could not be paid back if the crop yields are very poor as a result of shortage of rainfall.

Increased agricultural services, which are provided and supervised by the government, have also contributed to the extension in cultivated lands in Bay region. An increase in the provision of agricultural services, especially insecticides and improved seeds have been discerned by the local inhabitants (see Table 7.2). The foundation of these increased services dates back to 1952 when the Bonka Research Station was established near Baydhabo with the assistance of the Italian government. This station has mainly concentrated on sorghum breeding, correct spacing when seeding sorghum, appropriate weeding times and the use of farm-yard manure and insecticide. Unfortunately, work at this station has not been as fruitful and effective as would be desired because of the limited number of staff and a shortfall in financial support (HTS, Vol. 2, 1983). The station has been successful in introducing new varieties of sorghum, such as GBR 148 and Dabar, which were brought in from countries with similar environments to Bay region, namely Texas, Sudan, Egypt and Kenya. These have only been cultivated on a very small scale, although they ripen quickly, after only about 60 days of growth, compared to the local varieties, like Fududuq, which can be harvested after 90-120 days of growth. In this case, the new varieties have less time to be damaged by insects and birds. The main reason behind the reluctance of the agro-pastoralists to adopt these varieties is that they are less hardy and require a lot of inputs, such as insecticides, to preserve them during storage in <u>bakaar</u>. These methods, in terms of cost, are very expensive and the agro-pastoral households are frequently unable to provide the money necessary for purchasing the insecticides. Furthermore, even when agro-pastoral households can afford the money to purchase the insecticides, they are not always available in the market. Thus, the local varieties are preferred to the new varieties largely because of their superior storage characteristics.

In 1956, the Bonka Training Centre was established on a site adjacent to the above-mentioned station, with the assistance of United States - Agency for International Development (US-AID). At this centre, agro-pastoralists, especially those from the surrounding dry-farming areas of Baydhabo, were given a free two-week training course on improved dry-farming methods. It was reported that this centre used to train an average of 750 farmers per year, and encouraged them to settle down and cultivate the land (Planning and Coordinating Committee, 1963). The aim of this policy was to bring a larger area of rangelands under the plough. Since 1970, the strategy of this centre has been extended to cover a wider area of the dry-farming lands in Bay region. The implementation is carried out under the general agricultural policy of the Somali government which is based on the 'visiting and training system', whereby agro-pastoralists can be trained and supplied with agricultural services on their own farm lands (Ministry of Planning and Coordinaton, 1971). The agricultural extension services involve an increase in the free supply of insecticides and improved seeds, free chemical spraying of poisons against birds and, to some extent, in the renting of mechanical equipment like farm tractors. This system also includes the training of draught animals for farming purposes, the cultivation of the supplied seeds, like GBR 148 sorghum, and the encouragement of farmers to adopt other farming practices,like weeding. This has brought about a marked increase in the number of agricultural sections, staff and equipment over the last two decades. For example, in the early 1960s there was only one agricutural department established in Baydhabo, whilst by 1984 there were four agricultural sections with some 16 professional officers and assistants, 25 field extension workers and 19 auxiliary staff.

In spite of the increased provision of agricultural services, the analysis of the 1984 questionnaire survey (see Table 7.2) shows that only the problem of locusts has been successfully tackled, whilst the problems of bird and insect damage have had far less success. The drive to control locusts started as far back as the 1950s in Somalia (Planning and Coordinating Committee, 1963). Before 1950, locusts were a serious problem; for example in 1945 and 1949 sorghum seeds in areas around Baydhabo had no sooner sprouted than were devoured by swarms of locusts, thereby completely frustrating crop production in those two years. However, the last serious locust incursion in Bay region was in 1949, thus demonstrating the success of this programme.

Overall, it can be said that agricultural services have not generally attained their stated goals in Bay region, since most of the common agricultural problems still exist in the study area (see Section 5.6). This can be attributed to a number of factors. Firstly, there are still an inadequate number of trained and experienced agricultural agents, especially in relation to the continued increase in dry farming over the last few years. The agro-pastoralists therefore derive very little benefit from the visits of the agricultural officials. It was in fact reported that most of the improved seeds and insecticides were often supplied without adequate instructions on how to cultivate and use them. Secondly, the insecticides were often supplied in small quantities and irregularly. The relevant officials of the Plant Protection Department in Bay region and the Ministry of Agriculture in Mogadishu lay the blame for this problem on unpredictable supplies from outside aid agencies, such as the FAO of the United Nations. Thirdly, agricultural services are mostly given to those agro-pastoralists who are near accessible roads and tracks. The muddy roads and tracks during the rainy seasons make it difficult for the agricultural agents to reach those agro-pastoralists who are far from the accessible areas. Finally, the cost of fuel, as well as its shortage, go towards creating problems in renting farm tractors. The extra cost in paying the wages of tractor drivers, coupled with the malfunctioning or breakdown of tractors when most needed, are also part of the continual difficulties.

However, despite these efforts to improve farming practices, the fundamental problems still remain in this pattern of cultivation, because its success depends mainly on the amount of rainfall, which is unpredictable. Crop production is, therefore, a strategy of greater risk than animal grazing and, as such, it will remain a less reliable alternative to pastoralism for the foreseeable futher (Jamal, 1983).

9.6 Wood Collection

Wood collection for household purposes and charcoal production has increased over the last two decades in Bay region. Over 85 per cent of the 1984 questionnaire survey's respondents have confirmed this increase (see Appendix 2). This increase can be seen to be the result of a number of factors. Firstly, there has been an increase in local needs for firewood and timber since the required wood can be freely collected from the rangelands. This increase is not only due to the natural growth of the region's population, but also to the influx of in-migrants, since about 12.6 per cent of Bay region's people were enumerated as in-migrants from the surrounding regions during the 1975 population census (CSD, 1984). Secondly, the increased clearing of rangelands for dry-farming has correspondingly reduced the vegetation resources, especially the availability of woody species. This phenomenon is supported by testing the interrelationship between the two variables, increased firewood collection and the increase in the areas of dry-farming lands, from the results of the 1984 questionnaire survey (see Table 7.4). This provided a significant relationship at the 0.01 level of confidence. It can be argued that the expansion of dry-farming has, in fact, contributed to a new trend in pastoral life, with a tendency for many pastoral households to settle down to an agro-pastoral way-of-life. Consequently, these settled groups have put an increased strain on the available woody vegetation by constantly cutting down these woody plants, in areas adjacent to the settlements, in order to sustain household needs for cooking fuel and building materials. This is quite different to the pressure exerted by nomadic pastoral groups, as these are usually spread over a wider geographic area of rangelands, in relation to their movements from one place to another. Finally, the high and constant demand for charcoal in Mogadishu has led to an increase in the production of charcoal in Bay region and surrounding areas, with about three-quarters of the charcoal production of these areas being sent to Mogadishu, as discussed in Chapter Six. Thus, the increase in charcoal production has meant that extra woodcutting has been taking place, in addition to wood collection required locally for firewood and other household necessities.

The increase in Mogadishu's demand for charcoal is mainly because of its fast growing population, increasing from an estimated population of 172,677 in 1967 to 454,997 in 1975, showing a rise of about 163 per cent between these two years (CSD, 1977, 1983). The urban expansion of Mogadishu has, therefore, had a detrimental effect on surrounding and relatively accessible areas such as Bay region. This phenomenon has also been reported in other urban areas, as in Khartoum and Niamey (Grainger, 1986; World Resources Institute et al., 1986). There is little doubt that increased wood collection in Bay region has contributed to the decline of the more popular woody species for fuel and building demands like Acacia bussei, A. senegal and A. tortilis, as reported by the local inhabitants during the 1984 field work. This condition can be explained in two ways. Firstly, there has been no attempt to replace the cut trees or bushes, even in areas where semi-permanent camps for charcoal production have been established. Secondly, there is no protection for young shoots, growing out of the stumps of the cut plants, against animal grazing and trampling, since the rangelands are openly used for grazing purposes with little control or management. Thus, this grazing pressure aggravates the problem by hindering the re-growth of the cut plants.

Since the late 1960s, the government has taken some steps to limit wood cutting by enforcing a ban on the export of charcoal from Somalia and by controlling charcoal production itself (Planning Commission, 1968). Nevertheless, the government's efforts have not led to any positive consequences, since wood collection for charcoal production, or to be used as firewood and timber, has actually increased. The main reason behind this is that the available woody plants are the cheapest source of supply for both cooking and building purposes. The high price of imported fuel and building materials cannot be afforded by the local inhabitants. For example, in 1984, one kilogram of charcoal cost 3.5 Somali Shillings, while a litre of kerosene was valued at 7 Somali Shillings, equivalent to about 8.65 Somali shillings per kilogram of charcoal, although the calorific value of charcoal (for example 1 kg = 7,500 cal) is usually less than that of kerosene which is 12,000 cal per kilogram (Hammer, 1980). The oil refinery at Mogadishu, established and jointly developed with Iraq in 1979, could reduce the pressure on woody vegetation in the whole of Somalia, and particularly Bay region, by supplying the local markets with the required fuel oil, principally kerosene, at lower prices. However, the refinery was soon closed down because the supply of crude oil from Basrah, in the southern area of Iraq, has not been available since October 1980 due the Iraq and Iran war.

Woody plants, unfortunately, are considered by many in Bay region to be similar to the soils, in that they are seen to be an inexhaustible resource. Increased wood collection, along with heavy grazing, can, in fact, play a major role in converting the woodlands of Bay region into desert-like environments, with only a thin vegetation cover, as has already been reported elsewhere in the Sahelian - Sudanian zones (Timberlake, 1985). Consequently, soil erosion accelerates, as a sign of increasing desertification, and this can create difficulties for tree or bush seedlings in trying to re-establish themselves (Tivy and O'Hare, 1985). This condition represents a great threat to the maintenance of pastoral ecosystems.

9.7 Summary

Analysis in this chapter suggests that technological and economic factors, as an explanation of land-use changes over the past 20 years in Bay region , have increased in importance. These factors have involved improvements in water supplies, veterinary services, livestock sales and slaughter, farming practices and wood collection. The productivity of rangelands in terms of range forage supply, soil fertility, woody resources have in turn decreased. The following chapter deals with socio-political factors as further explanation of land-use changes in the region.

CHAPTER TEN

SOCIO-POLITICAL FACTORS

10.1 Social Factors

The social obligations of pastoral groups have contributed to land-use changes in Bay region. One of the most important emanates from the marriage system, particularly bride-price, involving practices which have a negative effect on the rangeland ecosystems. Bride-prices (meher) have traditionally been paid in the form of several grazing animals and, consequently, considerable numbers of animals are circulated among pastoral households through this custom. Indeed, this practice is one of the main reasons for preserving a large numbers of livestock in the study area, in keeping with other pastoral groups elsewhere in Africa (Carr, 1977; Strange, 1980c).

The change from the reliance on livestock as a form of payment to the greater use of currency, as discussed in Section 9.4, has had some effect on bride-price arrangements. The bride-price now involves a larger proportion of cash settlement and fewer livestock as, reported by the local inhabitants during the 1984 field work. Massey (1987) has also indicated that the bride-price, in the form of several animals, has diminished, whilst the use of money to satisfy the obligations of bride-price has increased among more recent generations in Bay region. Nevertheless, this modification has done little to reduce the grazing pressure on the rangeland ecosystems, because, although there has been some decline in livestock circulation through the bride-price system, the number of livestock has actually increased, as the loss of livestock caused by lack of water and outbreak of diseases has declined over the past 20 years.

There are, nevertheless, still greater opportunities for multiple marriages for members of those households who have greater numbers of animals. The results of the 1984 questionnaire survey show that 37 per cent of the households interviewed had two or more wives, and a herd of 36 livestock units per household, a higher than average herd size in Bay region of 32 livestock units. The importance of polygamy among the Rahanweyn groups of the region can be seen, in that it increases the availability of labour in the household. The practice in the laba bahood (a polygamous family) is generally that the first wife, and two or three of the children in the household, are involved in crop production. The second wife, who will normally be younger, takes the rest of the children with her to graze smallstock and cattle. Herding of camels is assigned to the young men of the household, like sons, brothers or brothers in-law. Where there is a third wife in the family, she usually looks after the remaining domestic work. Polygamy, therefore, leads to larger families, and this implies that extra household activities, like animal grazing, dry-farming and firewood collection, are required in order to cater for the family's needs for food, fuel and building materials. Because of this, the social system contributes to greater pressures on the rangeland ecosystem, since there are no realistic alternative means of livelihood, other than the exploitation of the available range resources through the raising of animals, planting of crops, excavating of waro and wells, and the gathering of firewood, timber, honey and wild fruits.

A further social factor is the migration of some members of pastoral households to the neighbouring urban areas of Mogadishu, Baydhabo, Bur Hakaba, Dinsoor and Kansadheere, and occasionally beyond Somalia (for example, Saudia Arabia), in search of jobs, and this, in turn, can have an adverse effect on the rangeland ecosystems of Bay region. Table 10.1 shows that almost 21 per cent of the pastoral households have members currently involving themselves in this type of migration, and these migrants are mostly males, ranging in age between 15 and 44 years.

Table 10.1 Number and percentage of pastoral households currently having family members working in towns inside and outside Bay region, 1984.

Sex type	No. of households	%
Male	32	13.3
Female	11	4.5
Both	7	2.9

The total number of households surveyed: 240.

Source: Compiled from the 1984 questionnaire survey.

From field discussions these migrants leave their families behind on the rangelands to look after the livestock as well as to raise crops. On average, they remit about one-third of their earnings to their families at home, and this becomes an extra and very important source of income for those households. These remittances, however, are generally invested in livestock, rather than in improving the productivity of the cultivated lands, with the result that herd sizes are constantly growing. For those who invest in cultivation, this has led to a less rapid, but nonetheless significant, expansion of the cultivated area of Bay region. Both types of investment can be seen as a direct investment in the experience and skills of those household members left at home, and forms the only realistic means of investment of that money under present production conditions. In this case and under these conditions, the capital sent home from the migrants is sensibly managed, as livestock and crops constitute the main source of livelihood for the people of Bay region. Nevertheless, the result has been to bring about increased stress on the rangeland ecosystems, since the capital which is invested in keeping larger numbers of animals, under unimproved grazing practices, only serves to aggravate the problems of rangeland deterioration, especially overgrazing and soil erosion. In addition, the increase in areas under cultivation, allied with uncertain rainfall conditions and unimproved agricultural techniques, further depletes the range resources, particularly in reducing soil fertility.

The migration of pastoralists to the urban areas of Somalia is substantial among the local inhabitants of Bay region. Almost all surveyed households (see Appendix 2) have indicated that the migration of people from the rural areas of Bay region to the towns has increased in the past 20 years. The main factors which have enhanced this pattern of migration are, firstly, the preference of pastoral groups to sell their animals and other products in the markets in urban areas in order to gain higher prices, has helped to build up social and economic relationships between the pastoral people and the urban dwellers. It is, therefore, less difficult for pastoralists to adapt themselves to urban life, once a job is secured. Secondly, the increase in the number of schools in the pastoral areas (see Appendix 2) has improved literacy rates, especially among young people. As such, those who can read and write find it much easier to obtain jobs in government departments, like the veterinary sections, which are mostly located in the towns. Thirdly, the relatives of the pastoralists already living in the towns act as an incentive to migrate to the urban areas, and, to a great extent, many of them are helped not only with accomodation, but also in finding jobs. Finally, the construction of improved roads and tracks in Bay region and neighbouring areas (see Appendix 2) makes for easier transportation between the rural and urban areas.

A third social factor of importance in understanding rangeland pressures is that of reciprocal labour. The principle of this system is that pastoral households, usually relatives and neighbours, help each other in grazing and farming practices, in order to overcome labour shortages at key times, such as when the types and numbers of animals exceed the capabililty of available family labour. The co-operative herding system (<u>kaalan</u>) is one of the adopted forms in dealing with 'exchanged labour' in Bay region. This system involves herding the camels and cattle of those households with labour shortages, by those male relatives, like nephews, who are not paid for their work, but who can drink the milk of the animals and may receive gifts of clothes. Households receiving help through the practice of <u>kaalan</u> are expected to give back help, when possible, in the next seasons or years. Thus, pastoral housholds can manage each other's herds during critical times, so reducing the necessity to dispose of animals, by selling or exchanging surplus stock, according to the constraints of the family labour supply. An additional advantage of this system for the household is that pastoral households involved do not incur the costs of hiring extra labour. This might entail, for example, giving the cash equivalent in animals to the hired herdsmen as payment for labour, as occurs in the case of the gowsaar system. The net result of the kaalan system is that pastoral households can maintain larger numbers of animals, even during periods of family labour shortages, when they would otherwise have to sell livestock. Consequently, grazing pressures on the rangelands are maintained.

The system of daab wareeg also militates against the careful husbandry of resources. Literally, daab means the handle of the hoe and wareeg means circle; thus daab wareeg means to circulate the handle of the hoe among the agro-pastoral households. This method is another form of interchange of labour in the study area, relating particularly to cultivation. Daab wareeg is usually practised among neighbouring households in order to supplement their labour needs. The principle is that all the co-operating members agree to work on each other's farms in turn on consecutive days, until each member's farm is cleared, weeded or harvested, depending on the agreed job. By this agreement, each member of a daab wareeg is bound to work with and for other members, who have worked for him. The advantage of this co-operative system is that there is a larger work-force, and so each member will end up cultivating more land than a household could possibly have done, or used to do on its own. As with the kaalan system, cropping practices can be achieved without the need for hired labour, which would require the conversion of some part of the household's capital, mainly animals and/or crops, into cash for paying the wages of workers, as occurs in the case of barbaar system.

The reciprocal labour system enables pastoral groups to achieve their production aims, in spite of shortages of household labour. Nevertheless, this system can be considered to produce a further human pressure on the rangelands of Bay region, in that it has led to an increase in the number of animals which can be looked after by a given labour unit, as well as to an increase in cultivated areas, where again, labour shortages constraining the amount of land that can be cultivated, are of limited importance. All leads to increased stress on the rangeland ecosystems.

However, from field discussions, the practice of reciprocal labour appears to be on the decline among the Rahanweyn groups of the study area. Increasingly, those who are able to work for others now mostly prefer to work as hired labour through the qowsaar and barbaar systems. The main reason for this is that it allows the labourer to accumulate capital (animal and/or cash), subsequently to be invested by the labourer in his own farm interprise. This is a highly logical response, as such individual farms are the principal means by which impoverished families can attempt to secure a reliable livelihood (ILO/JASPA, 1977). This change can largely be explained in terms of the general loosening of reciprocal socio-economic strategies in subsistence pastoral societies. In particular, the greater role of a commercial economy, as a result of increased animal sales, for example, has resulted in the need for more cash for investment, at the same time as social obligations, in the form of reciprocal labour relationships, continue to weaken among pastoral groups. This implies that pastoral production systems, especially of livestock, and labour itself have taken on much more of an exchangable value (Swift, 1977; Behnke and Kerven, 1984). Nonetheless, the result of this shift of emphasis also leads to increased stress on the rangeland ecosystems. The qowsaar system, for example, leads to an increase in circulation of livestock among the local inhabitants, since a herdsman works on the basis of an animal contract, and receives, in return, a cow of 2 - 3 years of age (if it is a cattle herd) or one male camel of two years of age (if it is a camel herd) for each year of service. Furthermore, the barbaar system (which requires money to be paid to the hired labourers for their work on the cultivated farms) provides an income which is then mostly invested in buying up more livestock. This is very similar to the pattern of migrants, who send their savings home to be invested principally in more livestock, without concomitant improvements in land quality, controlled grazing or husbandary techniques. However, despite these associated changes, it appears that these social values and attitudes help to increase pressure on the rangeland ecosystems, since wealth and social status among the pastoral groups are still assessed primarily in terms of animal numbers and, to a lesser extent, in terms of crop production.

10.2 Political Factors

Government policies towards the development of the social and economic life of pastoral people, as well as the efforts of international organizations, such as the EEC, to alleviate some of the ecological problems like lack of water and the outbreak of rinderpest, have led to land-use changes in Somali rangelands in general and in Bay region in particular. One of the most successful government achievements is its development policy on livestock production, this being promoted through five main projects: water supply in the rangelands; veterinary care; livestock marketing; range management; and livestock cross-breeding.

Water supply projects have been executed by establishing a great many new waro, shallow wells and deep-bore wells. To a lesser extent, water pumps are provided and those watering points, which have been misused, are repaired and cleaned for future use. In pursuit of their policy on water supply, the government planned in the Short Term Development Programme of 1968 - 1970, for example, to construct 75 waro, 75 shallow wells and 100 deep borewells over Somalia, in addition to the 40 large waro which were constructed with the financial and technical assistance of the EEC in the southern regions of Somalia, including Bay region (Planning Commission, 1968). In addition, the Five Year Development Programme (1974 - 1978) was designed to establish 750 waro, 150 shallow wells and 200 deep borewells over Somalia (Ministry of Planning and Co-ordination, 1974). A further 500 waro, 250 shallow wells and 250 deep-bore wells were proposed in the Five Year Development Plan of 1982 - 1986 (Ministry of National Planning, 1982).

This policy is a sensitive response to the pressing needs of the pastoralists for water, because the Somali range areas, especially those which are far away from the Juba and Shebelle rivers, like Bay region, are subject to water deficiencies, being totally dependent on underground and stored rainwater. In this case, the establishment and drilling of extra waro and bore holes can substantially alleviate the problem of thirst of livestock. Nevertheless, this policy has put an additional pressure on the pastoral ecosystem, because these new watering points have been planned only to meet livestock needs for water, without careful management to control the pastoral practices of livestock owners. For example, the increasing number of watering points in the rangelands of Bay region (see Section 9.2) has led to an expansion in the area of land available for grazing. This means that pasture lands hitherto unused for grazing, owing to lack of water, are now being utilized, and this, in turn, has contributed to the desire by local pastoralists to keep greater numbers of livestock. The local pastoralists justify this practice on the grounds that such domestic animals are their chief means of livelihood. The main consequence is that the number of livestock has increased to a point where most of the Bay region's rangelands have become overgrazed (see Section 8.2). Mahony (1966) has come to a similar conclusion in his study of the area near Afmadu in the southern part of Somalia. He warned that overgrazing might spread to the entire study area, because of the increasing number of watering points (which can make formerly unutilized rangelands available for grazing) and the increased number of livestock. Undoubtedly, the increase in the number of watering points in Bay region has given rise to increased overgrazing, thereby leaving only small parcels of unaffected rangelands between the overgrazed zones, as shown in Section 9.2.

Veterinary care is another government project introduced to enhance livestock production. The aims have been to improve animal health, and, consequently, to reduce the mortality rate of animals caused by disease. To achieve these aims, trained veterinary staff are essential. In this respect, the 'Training School for Animal Health Assistants' was established in 1967 at Mogadishu, with the assistance of the Special Fund of the United Nations, in order to improve the technical level of veterinary staff (Planning Commission, 1968). This school was initially established to train about 30 students per year, but the annual intake was raised to 120 students by 1973, owing to the need for more trained personnel in veterinary work (Ministry of Planning and Coordination, 1974). Besides the need for trained veterinary staff, there was also the need to produce the required sera and vaccines for treating the common infectious diseases such as rinderpest, black quarter, anthrax, bovine and caprine pleuropneumonia, heamarragic septicaemia, and foot and mouth disease. To meet these needs, the government established the 'Serum and Vaccine Institute' in the early 1960s at Merca. This institute was later, in 1969, moved to Mogadishu with the expansion of facilities to support the increasing demand for sera and vaccines. For example, vaccine production in 1968 was 1,327,900 doses increasing to 1,827,800 doses in 1972, with a further increase to 11,714,850 doses in 1981 (Central Statistical Department, 1973; 1980). Furthermore, the government embarked on individual programmes to eradicate rinderpest disease and control tsetse-fly which are a menace to livestock, cattle in particular, as elsewhere in Africa.

The rinderpest eradication programme was started in 1969 when Somalia joined the 'Pan-Africa Rinderpest Control Project'. This project made it possible for the Somali government to control effectively this cattle plague, through the financial and technical assistance of the Organization for African Unity and cooperation with other east African countries (Ethiopia, Sudan, Kenya, Tanzania and Uganda). Since then, the Somali government has made good progress: firstly, to vaccinate all adult cattle at least once a year; secondly, to vaccinate the calf crop at least once in two years; and finally, to keep neighbouring countries informed of any outbreak of rinderpest. This programme seems to have achieved a measure of success, in that about 90 per cent of Somali cattle were by 1975 vaccinated against rinderpest (State Planning Commission, 1979).

Tsetse-fly control was started in 1974, when the Somali government established the 'Tsetse Control Unit', at Afgoi. The operation of the plan was to spray insecticide from both aircraft and manual pumps carried overland in the infested riverine areas of the southern part of Somalia. Tsetse-fly has thus been reasonably controlled too, especially in the riverine areas of the Shebelle river, as the officials of the Ministry of Livestock, Forestry and Range confirmed during the 1984 field work. For example, it was disclosed that the region between Balad and Afgoi, which is part of the middle Shebelle course, has so far been cleared of the infestation of tsetse-fly with the financial and technical assistance of Great Britain.

The government has been trying to extend its prophylactic and curative veterinary services to many more localities in the Somali rangelands, by way of increasing the number of animal dispensaries, both at permanent sites and as mobile units. The officials of these dispensaries periodically vaccinate domestic animals against contagious diseases, and also give drugs to treat the endo- and ecto- parasites. For example, it was planned to establish 20 mobile vaccination teams during the Five Year Development Programme, 1974 - 1978 (Ministry of Planning and Co-ordination, 1974), and 60 other mobile vaccination teams in the Three Year Development Plan, 1979 - 1981 (State Planning Commission, 1979). In respect of parasite treatment units, it was planned to set up 48 parasite treatment centres during the Three Year Development Plan, 1979 - 1981 (State Planning Commission, 1979). In the Five year Development Plan, 1982 - 1986, 20 permanent spray races, 50 mobile dips for small stock and 400 mobile sprayers for cattle and camels were established (Ministry of National Planning, 1982).

The overall effect of this impressive veterinary care project is that many livestock are now saved from death from diseases. The improved survival rates of livestock, however, have meant that the number of livestock on the rangelands has increased significantly in recent years. The government, though, has still not introduced a coherent plan or set of measures to develop and increase the availability of the range forage. The veterinary care project can be considered to be only a partial development, since it would appear to be contributing to increased range stress, despite its good intentions.

The third project in the government livestock programme is to provide improved marketing facilities. With these, marketable livestock can easily be disposed of. Where marketable livestock are duly sold, grazing pressures on the range resources can be considerably reduced and, as such, the remaining livestock will have improved grazing conditions on the rangelands. The project was designed to bring about a balance between the number of livestock and the carrying capacity of the rangelands, and its implementation has necesitated the development and expansion of internal and external marketing systems for livestock.

For example, new livestock markets, such as in Dinsoor (within Bay region), Bardeera, Kimayo and Afmado, have been opened. This was an attempt to rationalize market operations in two ways. Firstly, such markets introduced new opportunities for livestock auctions; and secondly, the introduction of direct marketing practices between producers and purchasers could limit the profiteering role of middlemen. This meant that livestock owners could make greater profits in selling their livestock directly to purchasers. This being the case, the pastoralists were encouraged to sell a greater proportion of the marketable surplus of their livestock.

A further boost in the provision of proper marketing facilities was the establishment of Holding Grounds near the chief ports of export, such as Kismayo, Berbera and Mogadishu. The purpose of these Grounds was to provide vaccination, treatment, quarantine and reconditioning services to livestock purchased for export. The Jilib Holding Ground, for instance, was established as part of the EEC - Interriverine Development Project of 1970 - 1976 on a 20,000 hectare parcel of land, about 120 km from Kismayo (Ministry of National Planning, 1982). This Holding Ground was equipped with a veterinary section, quarantine station, pumped-well and the required staff. These services were quite effective in preserving the health of livestock and in reducing mortality rates and, as such, the animals could be exported in good condition. The establishment of the National Shipping Line in 1974, for transporting Somali produce, such as livestock, was another addition to the marketing facilities. This scheme aimed to reduce the inadequancy of shipping facilities, which contributed to the stagnation in livestock exports as evident in the 1970s

(Holtzman, 1982). The National Shipping Line started off with three livestock carriers, with a total capacity of about 16,000 tons. The Somali government later entered into a joint venture with a Greek Shipping Company in order to increase the shipping capacity for livestock. The Somali-Hellenic Shipping Agency (SHSA) was therefore established in 1979. Through this, the provision and charter of live animal carriers for Somali livestock exports, in particular to Saudi Arabia, became easier, especially important as Somalia had become increasingly dependent upon Saudi markets, to which it shipped more than 80 per cent of its livestock exports in the early 1980s, compared to 60 per cent in the early 1960s (Hartley et al., 1967; Ministry of National Planning, 1982). SHAS took steps to ensure that there were sufficient supplies of water, fodder and ventilation on the export ships for livestock. This paid off by minimizing the loss of livestock by death during the voyage to Jeddah, as reported by the SHAS officials and livestock exporters during the 1984 field work. These marketing facilities have stimulated the production of Somali livestock, not only as a source of meat for local markets, but also for external markets. Therefore, the involvement of pastoral groups in animal raising has increased, with all the implications this has for cattle herding in Bay region. As such, cattle owners manage to ensure the rebuilding of their herds and to keep up with market requirements (Dahl and Hjort, 1976; Behnke, 1984).

The fourth project initiated by the government with a view to improving livestock production was that of range management. Range management was first proposed in 1966 by the Livestock Development Survey Team of the FAO in pointing out the desperate need in the Somali rangelands for an agency to accept resposibility for the use and improvement of rangelands (Hartely _et al_., 1967). As a result, the Range Management Service was inaugurated in 1969 as a section in the Ministry of Livestock, Forestry and Range. This section became an autonomous office in 1976 as the National Range Agency (NRA), due to the increased responsibility it had to cope with. This led to a demand for more trained staff and the Range Training School was established at Burao (outside Bay region) in the early 1970s, with the financial and technical assistance of FAO. This school started with an annual intake of 20 students on a 2-year course, and this number was eventually increased to 100 students per year, owing to the increased need for trained staff in range management. The first programme of range management was one of the items in the Third Development Programme of 1971 - 1973, but it was only put into effect in 1979, with the declaration of the Range Development and Management Act. In relation to grazing pressures, this Act was mainly aimed at setting up measures against overgrazing and at improving livestock husbandry.

The main approach to range management was to demarcate specified areas of the rangelands, and to keep these free of grazing animals during the _Gu_ and _Dayr_ rainy seasons. These areas were refered to as 'Grazing Reserves' or 'Seasonal Reserves'. By keeping them out of reach of the grazing livestock during those periods of the year, their range resources could recover, and, therefore, range forage would be available for grazing in times of stress, especially in the _Jilaal_ dry season. These reserves comprised substantial grazing areas during the dry periods, especially since they are located near watering points. About 8 units of Grazing Reserves, having a size of about 1000 square kms each, have been established throughout Bay region's rangelands such as at Daaban and Weel Kabhan in the Bur Hakaba area, Safar Nooleys in the Dinsoor area and Buulo Ooman in the Yak Brawa area. About 80 range guards have been employed to protect these reserves by keeping livestock out during the closed periods, and monitoring grazing use during the open periods.

However, such range management techniques have resulted in little improvement in range conditions, as reported during the 1984 field work. There appeared to be no clear differences in the quantity and quality of range forage supplies between the reserved areas and the surrounding uncontrolled grazing areas. Several factors explain this. Firstly, since there was no fencing round the reserved areas, as well as inefficient guarding, due to the lack of transportation, these areas were not properly protected during the closed periods against animal grazing nor against other practices, such as wood collection. Secondly, no restrictions were imposed on the number of livestock to be allowed to graze during the times of use. Thirdly, no attempt was made to determine which species of livestock should be successively grazed in those reserved areas during the open periods. Finally, as no attempt has been made to control the growth of unpalatable plant species in the Grazing Reserves, the areas have become overgrown with useless shrubs, such as wanshagaar, at the expense of the more desired palatable species. With all these problems in range management, the project can be said to have had only limited positive results in terms of the improvement of livestock production.

The fifth project introduced by the government to develop livestock production is that of domestic animal cross-breeding. This project was started in 1976 when the Artificial Insemination Centre was established at Afgoi (outside Bay region). This centre carries out the cross-breeding of local cattle varieties with the more productive imported breeds, such as Friesian, in order to improve the milk and beef yields of the indigenous cattle. This centre has so far provided only limited services, and then only largely for the nearby government cattle farms. The reason for this is that the necessary storage equipment and a liquid nitrogen production unit are not yet available. Consequently, the centre is unable to produce deep-frozen semen capable of being used at more distant localities among the pastoralists. The overall assessment is that this project had made only a minimum contribution towards improving the local breeds of cattle, since the artificial insemination service is still largely absent in most regions in Somalia, like Bay region.

It can be concluded that the government's policy of livestock development has been successful in reducing the mortality rates of livestock, and also in bringing about an increase in the number of livestock units exported. In this context, the policy can be considered to be successful because domestic livestock constitute the main source of food and income for the majority of the Somali people, with over two-thirds of the Somali population being involved in livestock rearing and related activities (CSD, 1984). These improvements in veterinary services, water supplies and marketing facilities not only mean an improvement in the socio-economic life of particular pastoral groups, but also of the Somali nation as a whole. In particular, much of the rise in foreign exchange earnings can be attributed to increased livestock exports, providing between 70 and 90 per cent of the government's revenue of hard currency (Ministry of Natioal Planning, 1982).

On the other hand, the failure of the government to develop and improve the availability range forage, and its inability to influence the pastoralists to change their traditional livestock practices to more modern techniques, have contributed to increasing grazing pressures on the rangelands, leading to a gradual destruction of the pastoral ecosystem. This type of range deterioration is not unexpected, since no effective plans for the development of range forage or for managed changes in husbandry practices, have accompanied the programmes for increasing the number of watering points and improving the health of livestock and the marketing facilities. It is therefore hypothesized that such partial development, concentrating on the increase of water supplies, veterinary facilities and marketing facilities, as ends in themselves, can lead to an unstable pastoral ecosystem, as range forage resources become exhausted with overgrazing, and, consequently, the livestock eventually suffer too.

10.3 Summary

The above discussion has been concerned with examing socio-political factors as an explanation of land-use changes in Bay region. It appears that socio-political factors, such as polygamy, reciprocal labour and development policy on livestock production, have contributed to the increasingly stressful coditions being experienced on the rangeland ecosystems. For example, polygamy increases the size of a particular pastoral household and, as such, further land-use activities are required to support the family's needs for food, fuel and building materials. Human activities, in form of technological, economic, social and political factors, are markedly responsible for land-use changes in the rangelands, rather than the environmental factors themselves.

PART IV CONCLUSIONS AND RECOMMENDATIONS

CHAPTER ELEVEN

CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions

The main objectives of the study are to identify recent changes in land-use in Somali rangelands and to offer possible explanations for such changes. These objectives have been achieved in two ways. Firstly, by investigating pastoral techniques of rangeland-use in the form of animal grazing, dry-farming and wood collection, the main changes in pastoral ecosystems have been brought into focus. Secondly, explanations of these changes have been investigated as to whether they are the result of environmental factors, of human pressures or a combination of both. The major emphasis in the latter objective has been related more to the mismanagement of rangeland resources, rather than to significant changes in the environmental factors themselves, such as in rainfall patterns. This concluding section, therefore, presents a summary of the findings of this study.

11.1.1 The Tragedy of Communal Use of Rangelands

Rangelands in Somalia are generally used communally. This system applies to both pasturelands and woodlands, since these lands are recognized by the local inhabitants as communal resources, available to all members of the community. Only those range areas which have been cleared of vegetation, and are used actively for farming purposes, are recognized as a private right. The communal use of pasturelands and woodlands has led to an uncontrolled increase over the last 20 years in the number of grazing animals and in the cutting of woody plants. In the case of the communal pasturelands, for example, the increase in the number of livestock has resulted from a general feeling among the pastoral groups of Bay region that if a particular individual does not make full use of the available forage resources for his own livestock, then these resources will only be grazed by the animals of others. Consequently, each group tends to keep as many animals as possible, in order to maximize his gain from the available communal range resources.

This is reinforced by the fact that owning more animals gives greater security in terms of both social and economic values for the pastoral household. Therefore, it appears not to be in the interests of any individual to reduce his livestock numbers and hence reduce the grazing pressure on the vegetation cover, since that individual will have no guarantee that his neighbours will follow suit. Indeed, they may take the opportunity to increase their herd size to make full use of the available range forage released by the more conservation-minded. Thus, the continued accumulation of livestock has put greater pressures on the quantity and quality of range forage plants, until the pastureland has, inevitably, become overgrazed. The communal use of pastureland appears to have two different consequences: one is positive, and is related to the increased social and economic wealth of the community which comes from the increased livestock population; and the other is negative, and this is a function of increased grazing pressure on the pasturelands (Hardin, 1968). The end result is therefore potentially disastrous, as range forage plants eventually become exhausted, and, in turn, the livestock suffer too.

Overall, it can be said that the communal system, as a form of rangeland-use, is a tragedy as the management of range resources cannot be placed on a sound ecological basis. This arises from the fact that pasturelands and woodlands are communally owned, whilst grazing animals are individually owned, and fuelwood and timber are collected privately. This lack of management structure and co-ordination in the ownership of different elements of the production system means that there is little control over the use of pasturelands and woodlands, and these consequently become exhausted due to overstocking and overcutting. These uncontrolled practices contribute, in the long-run, to the process of range deterioration. Nevertheless, this ownership and land-use system is consistent with that of a nomadic pastoral pattern, in which there is only an intermittent or periodic use of environmental resources. However, under a more sedentary system, these resources do not have the opportunity to re-build themselves, and so deterioration sets in. The problem in Bay region would appear to be that some elements of the socio-economic livelihood system have changed (the nature of settlement and the nature of agriculture), whilst other elements (the ownership and use of communal resources) have remained unchanged, with the resulting potential and real tragic consequences.

11.1.2 The Scale of Pastoral Development

The scale of pastoral development is a crucial factor in the productivity of rangelands. Two planning perspectives usually considered in pastoral development are the comprehensive and the partial. In the comprehensive perspective, pastoral planning seeks to develop all elements of an existing production system at the same time. As such, pastoral ecosystems, in terms of water supply, range forage availability, soil fertility, veterinary and agricultural services, marketing and transport facilities, health and education services, and social and economic strategies of local inhabitants, are developed and improved as one. Pastoral development in Bay region, investigated in this study, does not show such a comprehensive approach. Various factors, ranging from a lack of adequate information on ecological potentials and constraints, the social and economic values and attitudes of pastoral communities and their associated problems, to the lack of adequate government organisation for planning, direction and coordination of pastoral development programmes, play prominent roles in the absence of a comprehensive development programme for pastoral ecosystems in Somalia in general, and in Bay region in particular.

Adopting a partial perspective, pastoral planning seeks to develop only certain parts of existing production systems, while other parts of the system are not sufficiently developed or remained unimproved. The study has shown that pastoral ecosystems in Bay region have been partially developed. The conclusion in Section 10.2 confirms that development has focused on the provision of improved veterinary services, water supplies and marketing facilities, whilst the availability of range forage, and improved and more efficient methods and techniques of animal grazing, crop production and wood collection have been largely ignored. This partial development has only disrupted the pastoral ecosystems of Bay region. For example, the rate of increase of livestock numbers has increased more quickly than the rate of improvement of the carrying capacity of the rangelands. One of the main reasons for this is that losses of livestock, due to lack of water or outbreaks of diseases, have decreased with these technical improvements. Consequently, such partial, technical developments have contributed to the maintenance of a condition of under-development.

However, planning activities, in both comprehensive and partial development, link up in a number of over-lapping areas, specifically the attempt to alleviate the impact of environmental problems, such as lack of water and outbreaks of livestock diseases. Unfortunately, the approach to the design of pastoral development during the period covered by the study does not show an awareness of these interrelated problems. More especially, the development programmes are not usually followed up by post-development evaluation, which could lead to improvements in subsequent development efforts. It is commonly accepted that the planning phase ends as soon as the project is brought into service. It is valuable to follow up the operations of the project, and to learn from its unanticipated problems and socio-economic and environmental impacts. Such analyses are invaluable for the future planning of pastoral ecosystems.

11.1.3 The Growth of Commercial Pastoralism

Over the past few decades, commercial pastoralism in Somalia has developed, and, increasingly, herds are primarily raised to meet market requirements for live animals. Pastoral households have, therefore, to possess a herd which is large enough to fulfill two different functions: the biological reproduction of the herd itself; and the maintenance of an off-take rate for marketing purposes. In addition to changes in herd sizes, there has also been a change in herd structures, from a reliance on camels and smallstock, to a reliance on cattle to respond to regional market requirements from the Middle East. As cattle have a higher market value, the future of Somali livestock marketing appears to be ensured. Thus, the development of commercial pastoralism has brought about a major change in herd management techniques, from a dependence on subsistence production, in the form of camels and smallstock, to a dependence on market production, in the form of cattle. The latter production system has also been encouraged by the increase in the provision of reliable water supplies and improvements in veterinary services, as cattle drink more frequently than other animals, and they are more susceptible to infectious diseases.

However, commercial pastoralism can have negative consequences on both pastoral strategies and rangeland ecosystems. In respect of pastoral strategies, animals which are now sold, were previously kept as insurance against ecological problems, such as droughts, or were used as an input into reciprocal networks, for the purpose of alms and loans to those in need in the family lineage. Consequently, pastoral strategies dealing with environmental disasters and maintaining social ties are now weaker than they were previously under subsistence pastoralism. Moreover, rangeland ecosystems have been put under greater grazing pressures, as Somali rangelands are predominantly covered by arid and semi-arid shrub or tree steppe varieties of vegetation which are ecologically not suited for cattle-rearing on a large scale. Thus, commercial cattle production has made the pastoral ecosystems highly susceptible to environmental problems like overgrazing. The result is that rangelands become progressively unable to sustain cattle herds. As such, a reversion in herd structures, from a reliance on cattle to a reliance on smallstock, for example, may be necessary. Smallstock are less harmful to rangeland ecosystems than cattle, and more are exported in terms of livestock units, than other types of livestock. Such a shift has already been reported in other parts of African rangelands, especially in northern Kenya (Le Houerou, 1985).

11.1.4 Decision-making Processes and Pastoral Development

Two aspects of decision-making processes in pastoral development are identified in the study. These aspects deal with the supply of and the demand for pastoral resources. These resources are generally affected by three different problems: low productivities; seasonal and annual variations in their availability; and vulnerable ecological conditions. The results of the study show that these two aspects of the decision-making processes have mostly been involved with development of water supply, veterinary care and livestock marketing. Nevertheless, Somalia has, during the period covered by the study, operated an irrational policy of pastoral development. The partners involved in making decisions for pastoral development were only the planners of the Somali government and international organizations. As such, the objectives and priorities of the pastoral people themselves were not taken into account in the pastoral development programmes. For example, the development of water supply, especially the construction of permanent watering points, in the rangelands of Bay region did not include the views of local inhabitants on, at least, where these points could most profitably be located. Thus, decision-making which ignores the opinions and priorities of local people may not succeed in solving fundamental pastoral problems.

Indeed, Briggs (1986) suggested that it is important that those people who are to be affected by such programmes should participate to a considerable extent in the planning process, as it is their lives that will be influenced and not those of the planners. In reality, the decision-making process poses a complex problem in the pastoral environments. In the case of the development of water supplies, for instance, pastoral households in Somalia may themselves not agree on where or how many water points should be placed or constructed, as several types of livestock are frequently kept on the Somali rangelands. This implies that many different levels and operations may be involved in making a right decision in pastoral development, joining together pastoral and planners' objectives into planning exercises.

11.1.5 The Seriousness of Unplanned Pastoral Settlements

It has been shown in the study that the pastoral people of Bay region have increasingly settled over the last 20 years to a mixed economy of animal grazing and crop production. This trend implies that pastoral people, under an agro-pastoral system, increasingly and more continuously exploit those range resources in the areas most adjacent to the settlements. Futhermore, these settlements have been generally established in places where permanent and improved water supplies, in addition to other environmental and socio-economic factors (like the capacity of soil to produce crops and the improvement in transport and marketing facilities) are available. Such unplanned settlements have led to concentrations of land-use activities (grazing, dry-farming and firewood and timber collection) and of larger numbers of people and livestock for longer periods of time in the surrounding range areas. Therefore, range resources, in areas of about 30 kms surrounding the settlements, have been exposed to an excessive exploitation of resources in terms of overgrazing, overcultivation and overcutting of woody plants. This is not unexpected, as water development schemes and other socio-economic programmes have not been accompanied by adequate range management in the surrounding areas. However, these environmental problems have resulted in the decline of the biological productivity of rangelands, in which pastoral ecosystems are now weaker than before. As such, droughts can have a greater impact on the quality and productivity of pastoral ecosystems, in spite of the continuous supply of drinking water. Thus, an optimal use of unreliable environmental resources in the short run is a necessary pre-condition for long-term production.

11.1.6 The Effect of Pastoral Migration to the Towns

The migration of pastoral people to the neighbouring urban areas inside and outside Bay region has increased in the last two decades. This migration has had a generally negative effect on the rangeland ecosystems of the region. As the migrants' families are left behind on the rangelands to take care of the livestock and to produce crops, the money saved and remittd home from the migrants is generally invested in livestock rearing and crop production. Such investments are reasonable to the extent that livestock and crops are the economic foundations for the economies of pastoral groups in Bay region. Nevertheless, these investments have led to an increase in the numbers of livestock and in the area of land under dry-farming. This suggests that capital sent home has contributed to further rangeland deterioration, in terms of increasing grazing pressures, soil erosion and infertility, rather than in improving the productivity of pastoral production systems.

11.1.7 The Hypotheses Revisited

The study focused on three hypotheses set out on pages 2 and 3. The results of the study suggest the following answers:

(1) Because of partial economic development in the rangelands, grazing pressures have surpassed the carrying capacity of the Somali rangelands. As such, the environmental resources, especially range forage resources, become exhausted because of overgrazing, and, consequently, the livestock eventually suffer as well.

(2) The unplanned pastoral settlements have also disrupted the rangeland resources. This is due to the spatial concentration of land-use activities, both cultivation and wood-cutting, in an unplanned way around the settlements.

(3) Those pastoral people who work in towns have contributed to increasing pressures put on the fragile rangeland ecosystems. This is because the land-use activities, in the form of livestock raising and crop production, have intensified over the last few years, as greater amounts of capital, generated through urban employment, have been invested in expanding animal numbers and in increasing the area under cultivation.

11.2 Recommendations

The conclusions of this study show that the interplay between the rangeland potentials and land-use activities has led to serious environmental problems in terms of overgrazing, overcultivation and overcutting of vegetation. This section, threfore, presents some suggestions that can contribute to a sound balance in fragile pastoral ecosystems, in that rangeland resources in Somalia in general, and in Bay region in particular, can sustain long-term production.

11.2.1 The Need for Rational Use of Rangelands

The problems of land-use have highlighted the need for rational land-use activities. The most important techniques that can be incorporated in the use of rangelands are: semi-enclosed ranching, rotation farming and woodlot plantations.

11.2.1.1 The Importance of Semi-enclosed Ranching

Semi-enclosed ranching has been used in Somalia, but on a very limited scale and only for commercial purposes. Only two cases of semi-enclosed ranching were reported in Bay region during the 1984 field work. The system typically comprises a group of livestock owners (about 25 members) in the form of a livestock raising co-operative. The Somali government gives special permission for members of the co-operative to fence range areas, as National Somali Law normally only allows rangelands to be fenced for rainfed cultivation activities. The fenced range area is about 10 hectares per livestock unit, to be used for grazing during the dry seasons, when range forage is seldom found on the communal pasturelands. This amount of land is enough to supply the dietary needs of one livestock unit per year under conditions of the lowest annual rainfall probability of, for example, 250 mm. As such, areas of semi-enclosed ranching provide a more realistic opportunity for livestock unit grazing in the semi-arid rangelands. This is especially so as the available grazing lands in Bay region do not have the capacity to be divided into permanent fenced range areas, at least not without a massive change in husbandry techniques. Therefore, semi-enclosed ranching can only be applied to agro-pastoral groups who keep cattle herds and have also adopted a more sedentary way of life. Furthermore, the productivity of areas of semi-enclosed ranching, in terms of the availability of herbaceous species, can be further increased by the removal of woody vegetation.

Semi-enclosed ranching can be used on a large scale in Somalia, in place of the current open ranching system. This can be achieved by allowing each agro-pastoral household to own an individual range area for grazing purposes. This suggestion can be supported in two main ways. Firstly, changes in herd management techniques, from a dependence on subsistence production to a dependence on market production, require the necessity to ensure enough fodder availability for cattle, especially during the dry seasons. This study has shown that a lack of fodder in Bay region is a serious environmental problem for cattle herds compared with other types of livestock (see Chapter 4). Secondly, semi-enclosed ranching will lead to the private control of pasturelands in the long run, as this system will allow each pastoral household to have an individual range area for grazing purposes. Consequently, range enclosure will end the communal use of pasturelands, with all the implications this has for better land management. In spite of the potentials of semi-enclosed ranching, this system can, however, lead to some grazing problems, especially those associated with the depletion of the more desired palatable plant species and tick-borne diseases. In respect of tick-borne diseases, for example, one of the main reasons for the short movements of livestock in the study area at the moment is to reduce the incidence of tick infestations (see Section 4.3). This implies that fenced ranching requires further research before implementation, especially on where semi-enclosed ranching should be located, by investigating environmental potentials and constraints, especially those which deal with water and range forage resources and livestock diseases.

11.2.1.2 The Importance of Rotation Farming

Rotation farming can be adopted by the agro-pastoralists in Somalia in order to cope with the ecological constraints of the semi-arid lands. This farming system involves dividing the dry-farming lands into two or more parts, in that each part can be cultivated in alternative years. This can maintain the productivity levels of the cultivated soils, allowing sufficient time for moisture to accumulate in the fallow years, especially when the fallow lands are kept weedless and, as such, valuable moisture and nutrients can be maintained in the soil. Thus, the cultivated soils can remain productive for longer periods of time. This rotational system will lead to an expansion in the area of cultivated land. There is still sufficient land available for such expansion in Bay region, as between 20 and 65 per cent of the arable lands of the region are still potentially available for cultivation (HTS, Vol. 1, 1982).

11.2.1.3 The Importance of Woodlot Plantations

The change from a nomadic pastoral system to a more sedentary pastoral system encourages the adoption of woodlot plantations, as the woody range vegetation soon becomes exhausted under conditions of more permanent settlements. These plantations can be developed in two locations: immediately adjacent to villages, in the form of communal village woodlots; and on the boundaries of farmlands in the form of individually-owned woodlots. In the case of village woodlots, each village community plants trees and bushes in areas of about 3 kms surrounding the settlement, in order to reduce the effect of desertification around the settlements, and to be used as a sources of firewood and timber. Individual woodlots, on the other hand, involve a plantation of rows of trees and bushes on the boundary of each household 's farmland in order to provide windbreaks against soil erosion. Such plantations have been recommended elsewhere in African and Asian rangelands (Burley, 1982; Eckholm et al., 1984).

Both communal village and individual farm woodlots have to be protected from animal grazing and trampling, especially during the first years of growth. In addition, the relevant forestry departments may supply, free of charge the settlers with sufficient supplies of young trees and bushes. This can only be achieved by establishing forestry nurseries over the Somali rangelands. Nevertheless, woodlot plantations may have a negative consequence on crop production, as trees and bushes, especially those within the dry-farming areas, are often nesting sites for birds which can cause damage to crops. This implies that additional sprayings of poisons on the nesting sites of birds are necessary to control this problem.

11.2.2 The Need for In-depth Surveys of Land-use Activities

There is a lack of detailed information on land-use activities in Somali rangelands. Even those regional surveys of Bay region (for example, HTS, 1982, 1983; University of Wyoming, 1984) have covered only the general aspects of physical and human factors. There is a need for in-depth surveys of environmental and socio-economic resources and constraints to be undertaken, especially as land-use activities result from the interaction between man and the physical environment. Such in-depth surveys are essential for the comprehensive development of pastoral ecosystems. Indeed, there exists a great opportunity to achieve this need at a regional level, as regional surveys can be used as baseline information for in-depth surveys. This requires much investment in time and money to be mainly used in training staff, establishing stations to deal with measuring physical factors (for example, rainfall, vegetation and soil) and socio-economic factors (for example, grazing, farming and wood collection techniques, pastoral marketing, charcoal production and settlement patterns). However, in-depth surveys of land-use activities can not be achieved without the technical and financial assistance of international organizations.

11.2.3 The Need for Comprehensive Pastoral Development

A final fundamental recommendation to be drawn from this study is the crucial importance of a comprehensive approach to pastoral development. It is necessary to develop pastoral ecosystems as one functioning and interrelated system, as the development of only certain sectors of existing production systems in isolation has led to negative consequences for some rangeland ecosystems. As such, various applications of technology and the viewpoints of both participants and planners are needed to approach such pastoral development. It is not reasonable to undertake programmes of pastoral development without sufficient support in the form of finance, technology, trained staff and infrastructure. Somalia can not achieve such comprehensive development without foreign assistance in terms of money, experts and machinery, as it is one of the bottom ten low-income economies in the world. However, there should be a clear distinction between the term of pastoral development and that of pastoral settlement. The term pastoral development has, to many planners in the Somali government, become synonymous with the term pastoral settlement. For example, the main aim of increasing watering points in the Somali rangelands is not only to supply the local inhabitants and their livestock with water, but also to settle these inhabitants. As such, plans for pastoral development are part of the discussions of how to settle pastoral groups in Somalia, although this aspect is not official government policy. Such confusion can be found in many developing countries of the world. Arguably, this is the main planning issue affecting such rangeland environments today.

APPENDICES

Appendix 1 Somali Rangeland-use Questionnaire

1. Date:

2. The name of surveyed point:

Section 1

3. What age are you?

4. Can you read and write? Neither, reading only, reading and writing?

5. Do you practise grazing at present? Yes No.

6. Do you practise farming at present? Yes No.

7. Do you practise any other land-use activities (such as firewood collection, timber collection and charcoal production)? Yes No.

8. If yes, please state what?

9. Are you married? Yes No.

10. If yes, please state how many wives you have at present.

11. How many persons other than yourself live in your household?

12. Do you have some members of your family working in towns within or outside Bay region? Yes No.

13. If yes, please state:

(a) The number of persons.

(b) The sex status: Male Female

(c) The age of person(s).

(d) The name of towns.

<u>Section 2</u>

14. How many grazing animals do you own at present according to their types and sex?

	Female	Male
Camels.		
Cattle.		
Smallstock.		

15. How much of your herd do you own at present?

	None	>1/4	1/4-1/2	1/2-3/4	3/4-all	all
Camels.						
Cattle.						
Smallstock.						

16. How many of your grazing animals do you normally sell during the year?

	None	>1/4	1/4-1/2	1/2-3/4	3/4-all	all
Camels.						
Cattle.						
Smallstock.						

17. When do you usually sell your grazing animals?

	Gu			Hagai			Dayr			Jilaal		
	1	2	3	1	2	3	1	2	3	1	2	3
Camels.												
Cattle.												
Smallstock.												

1 = Early; 2 = Mid-; and 3 = End.

18. Do you usually sell males, females or both sex of your animals?

	Male only	Female only	Both
Camels.			
Cattle.			
Smallstock.			

19. How often do you slaughter your own animals?

	A	B	C	D	E	F	G
Camels.							
Cattle.							
Smallstock.							

A = Never; B = On special occasions; C = Dying animals; D = Weekly; E = Monthly; F = Annually; and G = Others (please state).

20. Do you usually slaughter males, females or both?

	Male only	Female only	Both
Camels.			
Cattle.			
Smallstock.			

21. How serious are the following problems for your own animals at present?

	Camels	Cattle	Smallstock
	4 3 2 1 0	4 3 2 1 0	4 3 2 1 0
1. Lack of water.			
2. Lack of fodder.			
3. Labour shortage.			
4. Rinderpest.			
5. Black-quarter.			
6. Anthrax.			
7. Haemorrhagic septicaemia.			
8. Foot and mouth disease.			
9. Bovin pleuropneumonia.			
10. Caprine pleuropneumonia.			
11. Helminthiasis.			
12. Animal diarrhoea.			
13. Trypanosomiasis.			
14. Tick-borne diseases.			
15. Other problems (please state).			

4 = Very serious; 3 = Serious; 2 = Neutral;
1 = Not serious; and 0 = Not serious at all.

<u>Section 3</u>

22. How many hectares do you farm at present?

23. How important are the following crops for your own cultivation?

	4	3	2	1	0
Sorghum.					
Maize.					
Cowpea.					
Beans.					
Sesame.					
Ground nut.					

Others (please state).

4 = Very important; 3 = Important; 2 = Neutral;
1 = Unimportant; and 0 = Very unimportant.

24. How much of your crop production do you usually sell during the year?

	None	>1/4	1/4-1/2	1/2-3/4	3/4-all	all
Sorghum.						
Maize.						
Cowpea.						
Beans.						
Sesame.						
Ground nut.						
Others (please state).						

25. Are you a member of agricultural co-operative at present? Yes No.

26. How long have you been cultivating your present farm?

27. How often do you gather crop residues to be used by your own animals when there is a lack of fodder?
Never Seldom Sometimes Often Always

28. How often do you gather crop residues for sale?
Never Seldom Sometimes Often Always

29. How serious are the following problems for your own crop production?

	4	3	2	1	0
1. Lack of rain showers.					
2. Shortage of labour.					
3. Crop damage by grazing animals.					

4. Crop damage by birds.
5. Crop damage by wild animals.
6. Crop damage by insects.
7. Weeds.
8. Storage losses.
9. Soil erosion.
10. Soil fertility.
11. Other problems (please state)

4 = Very serious; 3 = Serious; 2 = Neutral;
1 = Not serious; and 0 = Not serious at all.

Section 4

30. How important are these fuel sources for your domestic cooking?

	4	3	2	1	0
Firewood.					
Charcoal.					
Kerosene.					
Animal dung.					
Others (please state).					

4 = Very important; 3 = Important; 2 = Neutral;
1 = Unimportant; and 0 = Very unimportant.

31. How important is timber collection for your own use?

	4	3	2	1	0
House building.					
Fences.					
Animal pens.					
Others (please state).					

4 = Very important; 3 = Important; 2 = Neutral;
1 = Unimportant; and 0 = Very unimportant.

32. How far is it (in kms) to the nearest supply of firewood and timber for your own family?

Firewood   Timber

33. How often are you involved in the sale of firewood?

Never   Seldom   Sometimes   Often   Always

Section 5

34. Do you agree with the following statements?

4 = Agree strongly; 3 = Agree, 2 = Netural;
1 = Disagree; and 0 = Disagree strongly.

4 3 2 1 0

1. There was more rainfall 20 years ago.
2. There were more waro 20 years ago.
3. There were more wells 20 years ago.
4. There was more range forage 20 years ago.
5. There were more range plants 20 years ago.
6. There was more firewood collection 20 years ago.
7. There was more charcoaling 20 years ago.
8. There were more camels 20 years ago.
9. There were more cattle 20 years ago.
10. There were more smallstock 20 years ago.
11. There were more animal slaughters 20 years ago.
12. There were more animal sales 20 years ago.
13. Rinderpest was a greater problem 20 years ago.
14. Black-quarter was a greater problem 20 years ago.
15. Anthrax was a greater problem 20 years ago.

16. Trypanosomiasis was a greater problem 20 years ago.
17. Bovine and caprine pleuropneumonia were a greater problem 20 years ago.
18. Foot and mouth disease was a greater problem 20 years ago.
19. Haemorrhagic septicaemia was a greater problem 20 years ago.
20. Helminthiases was a greater problem 20 years ago.
21. Animal diarrhoea was a greater problem 20 years ago.
22. Tsetse-fly infestion was a greater problem 20 years ago.
23. Tick-borne diseases were a greater problem 20 years ago.
24. Veterinary services were better 20 years ago.
25. There were more areas under cultivation 20 years ago.
26. Crop damage caused by locusts was a greater problem 20 years ago.
27. Crop damage caused by insects was a greater problem 20 years ago.
28. Crop damage caused by birds was a greater problem 20 years ago.
29. Weeds were a greater problem 20 years ago.
30. Soil fertility was better 20 years ago.
31. There was more soil erosion 20 years ago.
32. Agricultural services were better 20 years ago.
33. There were more agro-pastoralists 20 years ago.
34. There were more pastoralists 20 years ago.

35. There were more pastoral movements 20 years ago.
36. There were more pastoral settlements 20 years ago.
37. There were more communications between pastoral groups and government agents 20 years ago.
38. There was more migration of pastoralists to the towns 20 years ago.
39. There were more road networks 20 years ago.
40. There were more schools 20 years ago.
41. Medical services were better 20 years ago.

Appendix 2 Perceptions of change in the last 20 years of selected ecological and socio-economic factors in Bay region, 1984.

Factors	Agree strongly		Agree		Neutral		Disagree		Disagree strongly		Total points score	Score as % of max.
	No	%	No	%	No	%	No	%	No	%		
1. Crop damage caused by locusts was a greater problem 20 years ago	228	95.0	3	1.2	-	-	-	-	9	3.8	921	95.9
2. There was more rainfall 20 years ago	211	87.9	7	2.9	4	1.7	3	1.2	15	6.3	876	91.2
3. There was more range forage 20 years ago	211	87.9	1	0.4	1	0.4	1	0.4	26	10.9	850	88.5
4. There were more woody plants 20 years ago	195	81.3	2	0.8	3	1.2	1	0.4	39	16.3	793	82.6
5. Soil fertility was better 20 years ago	187	77.9	2	0.8	8	3.4	1	0.4	42	17.5	771	80.3
6. Rinderpest was a greater problem 20 years ago	179	74.6	4	1.7	7	2.9	2	0.8	48	20.0	744	77.5
7. Tsetse-fly infestation was a greater problem 20 years ago	155	64.6	1	0.4	12	5.0	2	0.8	70	29.2	649	67.6
8. There were more pastoral movements 20 years ago	151	62.9	4	1.7	7	2.9	5	2.1	73	30.4	635	66.1
9. There were more pastoralists 20 years ago	145	60.5	2	0.8	3	1.2	1	0.4	89	37.1	593	61.8
10. There were more smallstock 20 years ago	115	47.9	2	0.8	7	2.9	4	1.7	112	46.7	484	50.4
11. Anthrax was a greater problem 20 years ago	113	47.1	2	0.8	9	3.8	3	1.2	113	47.1	479	49.9
12. Foot & mouth disease was a greater problem 20 years ago	107	44.6	2	0.8	9	3.8	2	0.8	120	50.0	454	47.3
13. Trypanosomiasis was a greater problem 20 years ago	102	42.5	4	1.7	13	5.4	-	-	121	50.4	446	46.5
14. Haemorrhagic septicaemia was a greater problem 20 years ago	109	45.2	-	-	4	1.7	-	-	127	52.9	444	46.2
15. Bovine & caprine pleuropneumonia were a greater problem 20 years ago	100	41.7	5	2.1	6	2.5	4	1.7	125	52.0	431	44.9
16. Black-quarter was a greater problm 20 years ago	98	40.8	4	1.7	11	4.6	3	1.2	124	51.7	429	44.7
17. There were more camels 20 years ago	90	37.5	5	2.1	2	0.8	7	2.9	136	56.7	386	40.2
18. Animal diarrhoea was a greater problem 20 years ago	81	33.8	6	2.5	15	6.2	7	2.9	131	54.6	379	39.5
19. Helminthiases was a greater problem 20 years ago	84	35.1	3	1.2	13	5.4	1	0.4	139	57.9	372	38.7
20. There were more cattle 20 years ago	81	33.8	2	0.8	8	3.3	6	2.5	143	59.6	352	36.7
21. There were more areas under cultivation 20 years ago	83	34.6	3	1.2	-	-	5	2.1	149	62.1	346	36.0
22. Crop damage caused by insects was a greater problem 20 years ago	82	34.2	-	-	3	1.2	3	1.2	152	63.4	337	35.1
23. Crop damage caused by birds was a greater problem 20 years ago	62	25.8	2	0.8	6	2.5	-	-	170	70.9	266	27.7
24. There were more pastoral settlements 20 years ago	40	16.7	1	0.4	11	4.6	6	2.5	182	75.8	191	19.9
25. There were more agro-pastoralists 20 years ago	41	17.1	2	0.8	3	1.2	2	0.8	192	80.1	178	18.5
26. There were more animal slaughter 20 years ago	28	11.7	1	0.4	6	2.5	9	3.7	196	81.7	136	14.2
27. There were more communications between pastoral groups and government agents	24	10.0	1	0.4	10	4.2	9	3.7	196	81.7	128	13.3
28. There were more firewood collection 20 years ago	29	12.0	2	0.8	-	-	4	1.7	205	85.4	126	13.1
29. There was more soil erosion 20 years ago	19	7.9	1	0.4	10	4.2	9	3.7	201	83.8	108	11.2
30. Tick-borne diseases were a greater problem 20 years ago	19	7.9	1	0.4	3	1.2	2	0.8	215	89.7	87	9.1
31. There were more waro 20 years ago	19	7.9	1	0.4	-	-	3	1.2	217	90.5	82	8.3
32. There were more wells 20 years ago	18	7.4	-	-	-	-	5	2.1	217	90.5	77	8.0
33. There were more animal sales 20 years ago	10	4.2	2	0.8	4	1.7	8	3.3	216	90.0	62	6.5
34. Agricultural services were better 20 years ago	7	2.9	2	0.8	3	1.2	1	0.4	227	94.7	41	4.3
35. There was more charcoaling 20 years ago	10	4.2	-	-	-	-	-	-	230	95.8	40	4.2
36. Weeds were a greater problem 20 years ago	7	2.9	2	0.8	-	-	3	1.2	228	95.1	37	3.8
37. Veterinary services were better 20 years ago	6	2.5	-	-	2	0.8	-	-	232	96.7	28	2.9
38. There were more road networks 20 years ago	5	2.1	-	-	-	-	-	-	235	97.9	20	2.1
39. There was more migration of pastoralists to the towns 20 years ago	3	1.2	-	-	2	0.8	-	-	235	98.0	16	1.7
40. Medical services were better 20 years ago	4	1.7	-	-	-	-	-	-	236	98.3	16	1.7
41. There were more schools 20 years ago	3	1.2	-	-	1	0.4	-	-	236	98.4	14	1.5

The total number of surveyed households: 240.
Maximum score for any one factor: 960.
Source: Compiled from the 1984 questionnaire survey.

Appendix 3 Relationship between more cattle 20 years ago and more range forage 20 years ago by using Chi-square test statistic.

		More cattle 20 years ago		
		Agree	Disagree	Totals
More range forage 20 years ago	Agree	79	126	205
	Disagree	4	22	26
	Totals	83	148	231

df = 1, critical value at 0.05 = 3.84
0.01 = 6.64
0.001 = 10.83

X^2 = 5.3; significant at 0.05 level.

Appendix 4 Relationship between more cattle 20 years ago and more animal sales 20 years ago by using Chi-square test statistic.

		More cattle 20 years ago		
		Agree	Disagree	Totals
More animal sales 20 years ago	Agree	7	3	10
	Disagree	74	145	219
	Totals	81	148	229

df = 1, critical value at 0.05 = 3.84

0.01 = 6.64

0.001 = 10.83

X^2 = 5.63; significant at 0.05 level.

Appendix 5 Relationship between more cattle 20 years ago and more pastoral movements 20 years ago by using Chi-square test statistic.

		More cattle 20 years ago		
		Agree	Disagree	Totals
More pastoral movements 20 years ago	Agree	45	106	151
	Disagree	36	40	76
	Totals	81	146	227

df = 1, critical value at 0.05 = 3.84
0.01 = 6.64
0.001 = 10.83

$X^2 = 6.8$; significant at 0.01 level.

Appendix 6 <u>Relationship between more areas under cultivation 20 years ago and more firewood collection 20 years ago by using Chi-square test statistic</u>.

		More areas under cultivation 20 years ago		
		Agree	Disagree	Totals
More firewood collection 20 years ago	Agree	19	12	31
	Disagre	67	142	209
	Totals	86	154	240

df = 1, critical value at 0.05 = 3.84

0.01 = 6.64

0.001 = 10.83

X^2 = 10.03; significant at 0.01 level.

Appendix 7 Relationship between more road networks 20 years ago and more areas under cultivation 20 years ago by using Chi-square test statistic.

		More road networks 20 years ago		
		Agree	Disagree	Totals
More areas under cultivation 20 years ago	Agree	5	81	86
	Disagree	0	154	154
	Totals	5	235	240

df = 1, critical value at 0.05 = 3.84
0.01 = 6.64
0.001 = 10.83

X^2 = 9.08; significant 0.01 level.

Appendix 8 Monthly rainfall variability characteristics for Baydhabo station in Bay region.

Periods	No. of years observ-ations	Jan.			Feb.			Mar.			Apr.			May			June			July			Aug.			Sept.			Oct.			Nov.			Dec.		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1922-1926	5	1.6	3.6	225.0	8.2	13.9	169.5	25.8	20.9	81.0	141.4	74.6	52.8	135.5	105.2	77.6	18.4	19.3	104.9	24.6	13.1	53.3	3.6	5.0	138.9	14.1	13.5	95.7	240.5	131.7	54.8	143.2	148.0	103.4	20.1	22.1	110.0
1927-1931	5	2.5	4.3	172.0	4.5	6.0	133.3	5.5	4.3	78.2	114.2	74.1	64.9	102.4	103.5	101.0	16.8	29.2	173.8	20.1	27.7	137.8	14.1	15.1	107.1	19.6	39.4	201.0	112.6	42.0	37.3	102.1	126.0	123.4	10.3	9.0	87.4
1932-1936	5	1.8	3.9	216.7	0.7	1.1	157.1	10.3	12.8	124.3	189.5	85.2	45.0	105.8	94.6	89.4	1.1	1.6	145.5	16.2	14.2	87.7	6.9	6.2	89.9	28.8	34.9	121.2	121.5	72.5	59.7	24.6	24.6	100.0	9.5	9.6	101.1
1937-1940	4	1.8	2.9	161.1	8.0	16.0	200.0	25.9	33.8	130.5	165.8	41.7	25.2	69.9	72.1	103.1	12.5	7.4	59.2	19.4	10.8	55.7	2.6	3.5	123.1	9.3	8.3	89.3	127.0	59.2	46.6	70.4	20.0	28.4	4.1	5.2	126.8
1951-1955	5	0.4	0.8	200.0	14.2	27.4	193.0	25.9	29.4	113.5	167.9	123.7	73.7	137.6	102.5	74.5	7.7	4.9	63.6	16.0	7.2	45.0	8.8	7.4	84.1	4.3	4.7	109.3	158.2	91.1	57.6	53.9	28.4	52.7	14.2	18.9	133.1
1956-1960	5	0.2	0.5	250.0	2.0	2.9	145.0	45.8	59.9	130.8	128.3	43.4	33.8	146.9	46.8	31.9	16.3	20.0	122.7	17.9	26.3	146.9	3.7	2.3	62.2	1.7	3.1	182.4	82.1	55.9	68.1	80.9	91.0	112.5	23.2	20.4	87.9
1961-1965	5	3.5	5.2	148.6	1.2	1.8	150.0	25.9	39.9	154.1	166.4	96.8	58.2	87.6	58.0	66.2	13.7	25.6	186.9	20.5	13.2	64.4	10.5	10.2	97.1	17.8	17.8	100.0	83.6	40.2	48.1	172.7	181.8	105.3	21.5	26.4	122.8
1966-1970	5	4.6	7.3	158.7	7.1	11.5	162.0	39.0	33.4	85.6	149.3	127.0	85.1	125.5	81.1	64.6	24.7	16.4	66.4	13.4	14.5	108.2	7.7	9.7	126.0	3.2	4.0	125.0	163.0	59.9	36.5	73.8	106.3	144.0	1.9	4.2	221.1
1971-1974	4	0.0	0.0	-	0.8	1.6	200.0	0.0	0.0	-	123.8	20.1	16.2	84.4	74.0	87.7	16.9	17.0	100.6	9.5	13.5	142.1	0.0	0.0	-	10.2	12.0	117.7	139.5	91.1	65.3	27.2	23.9	87.9	0.0	0.0	-
1978-1981	4	7.0	14.1	201.4	0.0	0.0	-	68.5	102.6	149.8	189.2	132.6	70.1	85.2	59.8	70.2	13.9	10.3	74.1	23.9	11.0	46.0	11.4	12.7	111.4	3.3	3.5	160.6	175.0	143.8	82.2	51.1	43.1	84.3	11.0	14.3	130.0
Long-term	47	2.3	5.4	234.8	4.8	11.6	241.7	27.0	42.3	156.7	153.0	85.9	56.1	109.9	78.8	71.7	14.2	17.5	123.2	18.2	15.6	85.7	7.1	8.7	122.5	11.5	19.5	169.6	139.9	88.4	63.2	81.9	101.6	124.1	12.0	16.2	135.0

(1) Mean monthly rainfall in mm.
(2) Standard deviation in mm.
(3) Coefficient of variation in %.
Source: Before 1960 computed from Fantolli (1965: 278); and after 1960 computed from unpublished records of Meteorological Service, Civil Aviation Department, Ministry of Land and Air Transport, Mogadishu, 1984.

Appendix 9 Monthly rainfall variability characteristics for Bardeera station outside Bay region.

Periods	No. of years observations	Jan.			Feb.			Mar.			Apr.			May			June			July			Aug.			Sept.			Oct.			Nov.			Dec.		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1922-1926	5	1.7	2.6	152.9	21.3	45.7	214.6	23.6	18.0	76.3	99.5	74.9	75.3	99.5	113.8	114.4	28.0	31.3	111.8	88.5	35.9	40.6	6.2	9.1	146.8	10.5	8.6	81.9	138.5	142.5	102.9	63.6	47.2	74.2	16.0	14.8	92.5
1927-1931	5	3.0	5.7	190.0	6.4	9.5	148.4	15.4	29.2	189.6	94.7	64.4	68.0	40.9	32.2	78.7	29.2	57.6	197.3	24.7	34.1	138.1	11.3	9.5	84.1	17.0	38.0	223.5	66.6	46.9	70.4	66.0	18.0	27.3	42.7	36.2	84.8
1932-1936	5	2.2	3.3	150.0	6.7	9.5	141.8	28.0	38.1	136.1	93.1	18.1	19.4	36.4	31.8	87.4	6.1	2.3	37.7	9.9	17.2	173.7	13.9	13.1	94.3	8.8	2.4	27.3	69.4	62.2	89.6	45.5	53.1	116.7	64.9	38.6	59.5
1937-1940	4	9.0	10.1	112.2	3.9	4.4	115.8	28.0	20.2	72.1	122.9	63.8	51.9	42.6	39.0	91.5	14.9	4.0	26.9	7.8	10.9	139.7	2.4	3.8	158.3	0.3	0.5	166.7	51.3	71.7	139.8	35.8	35.7	99.7	9.0	8.3	92.2
1943-1947	5	18.0	32.0	177.8	0.3	0.6	200.0	13.9	11.5	82.7	57.9	47.9	82.7	67.1	95.9	142.9	4.2	2.9	69.1	9.7	11.6	119.6	4.4	2.7	61.4	6.1	11.1	182.0	39.5	22.9	58.0	41.5	14.9	35.9	9.9	8.6	86.9
1948-1949	2	1.6	2.3	143.8	9.8	2.1	21.4	21.5	19.6	91.2	44.7	34.4	77.0	38.1	44.2	116.0	8.1	1.8	22.2	4.6	6.2	134.8	0.7	0.9	128.6	0.2	0.3	150.0	60.6	22.6	37.3	85.3	99.3	116.4	26.1	21.5	82.4
1953-1957	5	5.3	11.9	224.5	0.0	0.0	-	15.7	17.5	111.5	74.3	36.2	48.7	55.4	41.4	74.7	8.0	11.0	137.5	13.7	15.7	114.6	6.1	13.5	221.3	0.2	0.4	200.0	10.9	12.1	111.0	71.8	67.2	93.6	17.5	15.4	88.0
1958-1962	5	6.3	10.4	165.1	2.8	4.4	157.1	29.7	58.9	198.3	142.0	129.5	91.2	67.1	56.1	83.6	10.3	13.0	130.0	13.2	10.9	82.6	1.9	2.5	131.6	8.2	14.6	178.1	91.5	71.4	78.0	119.6	121.9	101.9	46.0	37.7	82.0
1963-1967	5	3.8	8.5	223.7	3.6	8.1	225.0	3.4	4.0	117.7	160.0	62.4	39.0	52.0	35.5	68.3	19.3	26.3	136.3	1.6	3.6	225.0	1.2	2.6	216.7	0.6	1.3	216.7	64.0	61.4	95.9	96.5	110.9	114.9	0.0	0.0	-
1971-1972	2	0.0	0.0	-	0.0	0.0	-	0.0	0.0	-	78.8	111.4	141.4	100.5	88.4	88.0	0.0	0.0	-	0.0	0.0	-	0.0	0.0	-	0.0	0.0	-	158.6	53.7	33.9	146.0	206.4	141.4	0.0	0.0	-
1979-1982	4	5.3	10.6	200.0	0.0	0.0	-	49.1	70.7	144.0	65.2	58.8	104.6	87.1	93.5	107.4	11.2	10.0	89.3	35.5	11.8	33.2	3.5	4.7	134.3	8.5	8.3	97.7	94.2	111.1	117.9	36.2	36.3	100.3	10.9	14.2	130.3
Long-term	47	5.6	12.6	225.0	5.1	15.7	307.8	21.3	32.9	154.5	97.3	70.6	72.6	61.4	63.2	102.9	13.7	23.5	17.2	21.0	30.7	146.2	5.3	8.3	156.6	6.2	14.0	225.8	72.8	76.2	104.7	69.6	74.3	106.8	23.8	29.5	124.0

(1) Mean monthly rainfall in mm.
(2) Standard deviation in mm.
(3) Coefficient of variation in %.
Source: Before 1960 computed from Fantolli (1965: 229); and after 1960 computed from unpublished records of Meteorological Service, Civil Aviation Depatment, Ministry of Land and Air Transport, Mogadishu, 1984.

Appendix 10 Monthly rainfall variability characteristics for Afgoye station outside Bay region.

Periods	No. of years observations	Jan.			Feb.			Mar.			Apr.			May			June			July			Aug.			Sept.			Oct.			Nov.			Dec.		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1953-1957	5	5.0	7.0	200.0	0.0	0.0	-	1.3	2.2	169.2	72.2	56.5	78.3	78.3	94.9	121.2	32.5	17.8	54.8	55.1	35.1	63.7	10.5	7.4	70.5	5.7	3.8	66.7	20.1	10.1	50.2	72.3	56.1	77.6	22.0	20.2	91.8
1958-1962	5	1.3	3.0	230.8	0.0	0.0	-	14.4	28.9	200.7	112.4	39.4	35.1	91.5	61.1	66.8	43.2	49.3	114.1	93.1	74.2	79.9	7.9	5.8	73.4	8.3	6.9	83.1	31.9	43.8	137.3	43.5	34.2	78.6	10.1	7.1	70.3
1963-1967	5	1.8	3.9	216.7	0.0	0.0	-	0.2	0.3	150.0	116.9	46.6	39.9	116.4	110.4	94.8	86.4	88.8	102.8	43.9	12.9	29.4	31.0	9.4	30.3	9.4	10.9	116.0	105.3	86.1	81.8	125.6	79.1	63.0	27.4	25.8	94.2
1968-1969	2	0.0	0.0	-	49.9	70.6	141.5	16.0	22.6	141.3	89.5	109.7	122.6	90.9	15.4	16.9	24.1	12.1	50.2	107.6	0.5	0.5	12.7	17.9	140.9	0.0	0.0	-	43.4	34.9	80.4	133.8	136.8	102.2	42.0	59.4	141.4
1971-1976	6	1.0	2.2	220.0	3.5	7.8	222.9	5.5	13.0	236.4	55.7	47.0	84.4	115.7	65.5	56.6	54.4	24.4	44.9	52.3	40.0	76.5	19.3	22.6	117.1	6.6	13.9	210.6	42.6	75.3	176.8	106.6	65.0	61.0	43.0	52.3	121.6
Long-term	23	2.0	4.1	205.0	5.3	20.6	388.7	6.4	15.8	246.9	87.9	54.2	61.7	100.3	75.6	75.4	51.5	49.4	95.9	64.7	45.9	70.4	16.9	15.8	93.5	6.8	9.4	138.2	49.1	64.2	130.8	91.9	69.3	75.4	27.8	34.9	125.5

(1) Mean monthly rainfall in mm.
(2) Standard deviation in mm.
(3) Coefficient of variation in %.
Source: Computed from unpublished records of Meteorological Service, Civil Aviation Depatment, Ministry of Land and Air Transport, Mogadishu, 1984.

GLOSSARY

<u>Abaar</u> - Drought.

Abyssinian goats - <u>Capra walie</u>.

<u>Aqallo</u> (plural of <u>aqal</u>) - Pastoral nomadic huts.

<u>Arafat</u> - The first day of pilgrimage.

<u>Baadiye</u> - Pasture lands.

<u>Bakaaro</u> (plural of <u>bakaar</u>) - Dome-shaped containers for crop storage, usually in the ground.

<u>Balanbaal</u> - <u>Abutilon figarianum</u>.

<u>Barbaar</u> - Hired farming labour.

Black-headed sheep - <u>Ovis aries</u>.

<u>Cadaad</u> - <u>Acacia senegal</u>.

<u>Cambulo</u> - Sorghum cooked in water with oil and sometimes sugar added.

<u>Ceelal</u> (plural of <u>ceel</u>) - Wells.

Cowpea - <u>Vigna sinensis</u>.

<u>Daab wareeq</u> - Reciprocal farm labour.

<u>Dabar</u> - An introduced sorghum variety, which can be harvested after 60 days' growth.

<u>Daremo</u> - <u>Chrysopogon plumosus</u>.

<u>Dayr</u> - Light rainy season (October - November).

<u>Dhamaaq</u> - <u>Grewia tembensis</u>.

<u>Dharkeen</u> - <u>Euphorbia robecchii</u>.

<u>Dorar</u> - <u>Paspalidium desertorum</u>.

<u>Dubaa</u> - A wedding feast.

<u>Fududuq</u> - Local sorghum variety, which can be harvested after 90-120 days' growth.

<u>Galool</u> - <u>Acacia bussei</u>.

GBR - An introduced sorghum variety, which can be harvested after 60 days' growth.

<u>Hareeri</u> - <u>Terminalia polycarpa</u>.

Groundnut - <u>Arachis hyporea</u>.

_Gu_ - Heavy rainy season (April - May).

Hagai - Slight dry season (June - September).

Haj - Islamic pilgrimage season.

Humba siib - _Schoenfeldia transiens_.

Hump-backed cattle - _Bos taurus_.

Ilo (plural of _il_) - Canals of a _war_.

Irman bariyeed - To give animals as a loan to those in the family lineage when in need.

Isha - Springs.

Iskashato (plural of _iskashata_) - Co-operatives.

Jebin - _Tetrapogon cenchriformis_.

Jilaal - Hard dry season (December - March).

Kaalan - Reciprocal herding labour.

Kawaawi - A farming system which is used to maximize soil moisture by dividing the farmland into a series of small square-shaped basins (no greater than 4 square metres) in order to retain as much rainwater as possible.

Laba bahood - A polygamous family.

Maize - _Zea mays_.

Mareer - _Cordia sinensis_.

Meher - Bride-price.

Merer oor gaabo - _Coffea paolii_.

Mokway - _Dignathia_ spp.

Mowluud - Prophet Mohamed's brithday.

Mundullo (plural of _mundul_) - Permanent agro-pastoral huts.

Nigo figiis - _Mundulea sericea_.

One-humped camels - _Camelus dromedarius_.

Qalaaliyo - _Euphorbia grandicormis_.

Qora - _Acacia tortilis_.

Qowsaar - Hired herding labour.

Red billed quelea - _Quelea quelea_.

Sadaquo - To give animals as alms to those in the family lineage who are in need.

Shootfly - *Atherigona indica*.

Soor - Ground sorghum cooked with milk as a thick porridge.

Sorghum - *Sorghum vulgare*.

Stalk borer - *Chilo partellus*.

Tugar - *Acacia nilotica*.

Waro (plural of *war*) - Excavated ponds for catching and storing rainwater, usually built out of earth (small or large *waro*).

Yaambo - Short- or long-handled hoe.

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