NIRP Research for Policy Series 17

Drought planning and rainwater harvesting for arid-zone pastoralists: the Turkana and Maasai (Kenya) and the Negev Bedouin (Israel)l

Hendrik J. Bruins, Joshua J. Akong'a, Marcel M.E.M. Rutten and Gideon M. Kressel

Colophon

NIRP Research for Policy Series

Part 17: Drought planning and rainwater harvesting for arid-zone pastoralists: the Turkana and Maasai (Kenya) and the Negev Bedouin (Israel)

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Mrs. M. Bar-Lev (Secretary)
CINADCO/Haigud
P.O. Box 30
Bet-Dagan 50250, Israel
Telephone: 972 - (0)3 9485441/5868
Fax: 972 - (0)3 9485761
E-mail: miriamb@moag.gov.il

Mrs. L. Minkman (Project Officer)
Training & Fellowships Desk/
Department for Human Resource and Institutional Development Nuffic
P.O. Box 29777
2502 LT The Hague, The Netherlands
Telephone: 31 - (0)70 4260192
Fax 31 - (0)70 4260189
E-mail: lminkman@nuffic.nl
Website: www.nuffic.nl/programma/research/nirp.html

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Preface

This study deals with problems of drought and drought-coping mechanisms among pastoralists living in arid zones in Kenya and the Negev (Israel). Its final objective is to provide input and formulate policy recommendations for the development of integrated drought contingency planning. The results are based on a cooperative effort by Kenyan, Israeli and Dutch researchers carried out under the NIRP programme between 1994 and 1999.

NIRP aims to encourage development-related research focused on socio-economic and cultural change. Being policy-oriented in nature, NIRP aims to make the results of research accessible to anyone interested in solving the problems investigated. The target groups for such knowledge include policy makers, representatives of non-governmental and donor organisations, and the scientific community. With this aim in mind, the Publication Board has launched the NIRP Research for Policy Series as a channel for the publication of "user-friendly" summaries of more than 30 scientific reports.

The Publication Board wishes to thank Dr. Mirjam A.F. Ros-Tonen for editing the summary on which this monograph is based. Thanks are also due to Howard Turner for revising the English.

Last but not least, the Publication Board wishes to thank the research team for the successful completion of this study. It would like to pay particular tribute to Mr. Francis M. Ndaraiya, who made valuable contributions during the conception of the project, while on a training visit in Israel, at the Jacob Blaustein Institute for Desert Research. He played a key role in Kenya in the logistical execution of the project, particularly with regard to communication, transport and field visits. He conducted pioneering rainwater-harvesting field trials in Kajiado District, in cooperation with the local Maasai, but disease prevented him from continuing and concluding

these experiments. He nevertheless collected a significant amount of important data during 1995, 1996 and 1997. He passed away after a severe illness on 18 December 1998.

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I. General information

I.1 Framework of the study

The recurring phenomenon of drought is a formidable hazard for 40 million pastoralists living in arid zones. Drought has a direct negative impact on the growth of natural pasture, often resulting in a lack of food for grazing animals and economic loss for their owners. The losses may supersede coping mechanisms and reach the level of a disaster. Vulnerability, reserves, economic strength and access to resources are key elements of drought-coping ability and the effect of drought on society (Fratkin and Roth, 1990; Downing and Bakker, 2000). Traditional drought-coping mechanisms of pastoralist societies, such as the formation of reserves and rainwater harvesting, seem to have become less effective, due to socio-economic and political changes in Kenya as well as Israel.[1] Socially, the tribal structure struggles with the prevalence of national law over tribal law. Changing land rights since colonial times have often led to a decrease in the area available for grazing, affecting traditional grazing patterns and drought-coping strategies (Rutten, 1992; 1998). Marginalisation of traditional pastoralists and nomadic pastoralism (Azarya, 1996) seem apparent in many parts of the world.

Drought contingency planning is gradually receiving more attention (Wilhite, 2000a, 2000b). It constitutes an important strategy to lessen drought impact for pastoralists in arid zones. Drought contingency planning may be developed at government levels – national and provincial – and at the level of the household or pastoral enterprise. Drought planning invariably involves the formation of reserves, whether in terms of water, grains or money (Schneider, 1976; Bruins *et al.*, 1986).

Rainwater harvesting can be a significant drought mitigation strategy at the local level. It involves the collection and storage of runoff water

[1] See Dietz (1987), de Bruijn and Van Dijk (1995), Fratkin (1998), Akong'a and Kareithi (1998) and Rutten (1992, 1998) for Kenya and Marx and Shmueli (1984), Kressel (1993) and Meir (1987) for Israel.

derived from rainfall. The runoff water from roofs or natural catchments can be stored either in containers (cisterns) as drinking water or in the soil for plant production. In terms of access, runoff water is often available at household level and this is an important factor as regards the enhancement of water security.

This study addresses the problems of drought and drought-mitigating strategies for arid-zone pastoralists in the Turkana and Kajiado Districts (Kenya) and in the Negev (Israel). The drought in Kenya of 1960-61 led to a nation-wide famine, as it came at a time when the country had exhausted its stocks of food reserves. Consequently, food had to be imported and massive relief food supplies accepted from external sources. This situation was repeated in 1979/80 and in subsequent years (Akong'a *et al.*, 1988). However, the level of world food reserves is steadily declining. Severe future drought and declining groundwater levels in China or India, the two most populous nations in the world, might lead to the rapid exhaustion of world food reserves and a large-scale famine in the 21st century (Bruins, 2000c). Therefore, international food assistance may not always be forthcoming in the future.

Focusing the project on three different areas was an ambitious undertaking in view of the moderate resources available. The dry, hot and remote Turkana District in north-western Kenya with an annual precipitation of 188 mm is quite different from the milder Kajiado District in the south of the country, situated close to the capital Nairobi and with an annual precipitation of 502 mm. Both areas are in the tropics (Table 1, Figure 1). The third area, the Negev desert in Israel, is situated in the sub-tropics and has a more developed infrastructure and economy (Figure 2). Here annual precipitation amounts to 92 mm. The comparative evaluation of the primary data of the three areas makes the conclusions more challenging and comprehensive concerning arid-zone pastoralism in the face of drought.

Table 1 Characteristics of the three study areas and their location by District Capital (Kenya) and University Campus (Israel)

	Population group	Precipitation (mm)	Latitude	Longitude	Altitude (m)
Lodwar, Turkana, Kenya	Turkana	188	3° 07` North	35° 37` East	506
Kajiado town, Kajiado, Kenya	Maasai	502	1° 50` South	36° 50` East	1.738
Sede Boker Campus, Negev, Israel	Bedouin	94	30° 51` North	34° 47` East	470

Source: Bruins *et al.*, 1999.

Figure 1 The two study sites – Turkana and Kajiado – in Kenya
(Source: adapted from Ole Katampoi *et al.*, 1990: 2)

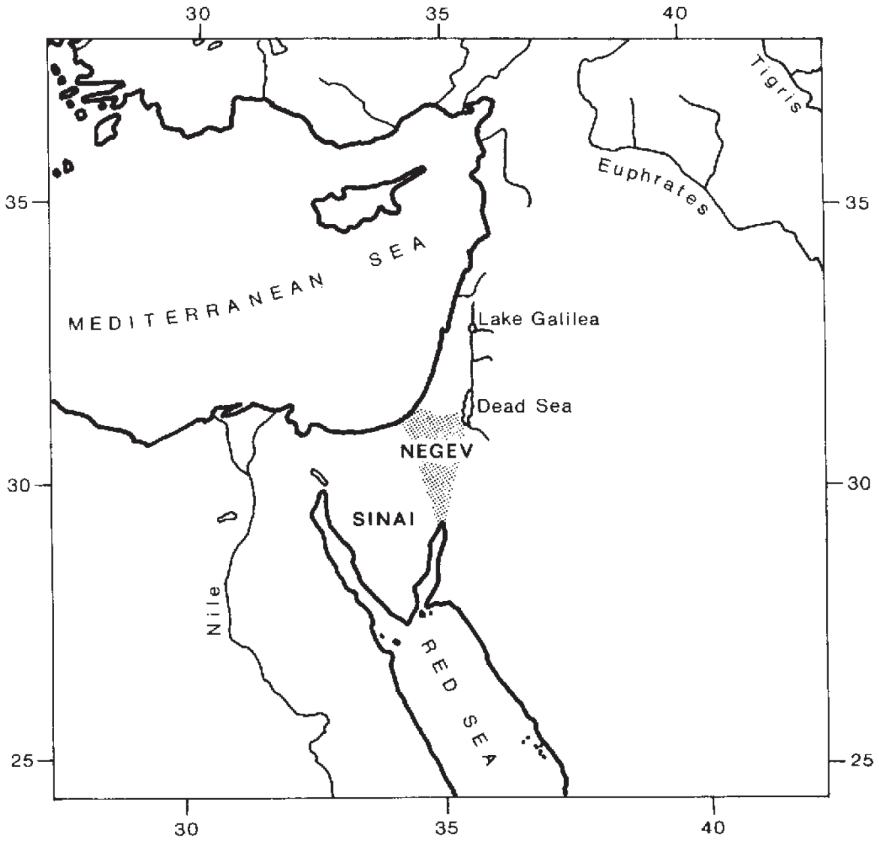

Figure 2 The Negev as a land bridge between Africa and Asia (Source: Bruins, 1986: 6)

The pastoral population groups targeted are the Turkana, the Maasai and the Negev Bedouin, respectively.

I.2 Objectives and research questions

The specific objectives of the project were the following[2]:

1. To study pastoral systems in relation to drought in three different drylands.
2. To study pasture resources in terms of aridity, drought and possible desertification, individually in each region and comparatively.

[2] Objectives 3 and 4 are only marginally addressed in this monograph. More information can be found in Bruins (1999). The same applies to the research questions 6 and 7.

3. To study observable changes in the pastoral and livelihood system, particularly in relation to supplementary fodder.
4. To study external interventions to assist in disaster mitigation related to drought against the background of sustainable development.
5. To study the use of rainwater harvesting and its significance.
6. To formulate policy recommendations for the development of integrated drought contingency planning, including the possible use of rainwater harvesting, in order to increase system viability and livelihood security of arid-zone pastoralists under more limited grazing conditions.

The specific research questions that are addressed in this monograph are:
1. What are the characteristics of pastoral systems in each study area?
2. What is the degree of aridity and the severity of drought in each study area (Turkana, Kajiado, Negev) in relation to the natural vegetation as the basic food resource in pastoral livestock-raising?
3. How is it possible to monitor drought in a practical and numerical way, so that a basis can be obtained for a drought impact assessment on pasture and the definition of drought thresholds in administrative frameworks as an integral part of drought contingency planning?
4. What are the indigenous approaches to drought in each region, past drought occurrence, drought impact and traditional drought-coping mechanisms?
5. Has rainwater harvesting been part of indigenous knowledge and practice, what types of rainwater harvesting occur in each region and what is the potential of rainwater harvesting in drought preparedness and mitigation planning?
6. Has drought led to a crisis or disaster and, if so, which interventions have taken place and what has been their effect?
7. What are the trends of pastoral development and possible system changes, particularly in relation to supplementary fodder?
8. How does development in general relate to drought vulnerability of pastoralists and how can vulnerability to drought be reduced?
9. What policy recommendations can be made for the development of integrated drought contingency planning in each region, particularly aimed at pastoralists?

I.3 Hypotheses

Donor organisations intervening in Sahelian disaster regions and in Turkana District concluded initially that pastoralism is unsuited for arid Africa (Cullis and Pacey, 1992: 189). Such a view was similar to the one held

by colonial and post-colonial governments. The basic assumption in this study is that livestock-raising is both rational and the only form of food production possible in regions too dry for rain-fed agriculture, in the absence of a sustainable source of irrigation water.

Pastoral system and management changes are, however, inevitable in many areas, due to diminishing free-grazing areas and socio-economic development. The increased use of supplementary fodder and auxiliary farming with rainwater-harvesting techniques seem the most logical adaptation to partly replace natural pasture in arid lands under more sedentary grazing conditions. Paradoxically, such a system may reduce drought vulnerability. In addition, the development of integrated drought contingency planning on a national and regional scale is essential to safeguard system viability in the face of drought.

I.4 Theoretical orientation

Planning may be defined as a bridge between knowledge and action (Faludi, 1987). This is the starting point for the theoretical approach that guided this study. Drought contingency planning for arid-zone pastoralists, as a bridge between knowledge and action to diminish vulnerability, has to be based on a rational evaluation of knowledge elements in order to propose a coarse of action, *e.g.* in the form of policy recommendations for household and governments.

Rational planning as developed by the Chicago School (Meyerson and Banfield, 1955) is generic, related to public policy, and involves decision-making and implementation. In theory, rational planning considers all the alternative courses of action in relation to existing conditions and the goals to be attained. It identifies and evaluates the consequences of each alternative, in order to finally select the most preferable alternative. Wildavsky (1979) argued, however, that in the real world, the rational planning model is inherently flawed. Indeed, no human being is able to grasp all the planning alternatives available at any moment and all the consequences that would follow any planning action (Faludi, 1987). Although there are limits to rationalism, structured thinking in the face of complex systems can be helpful (Bruins and Lithwick, 1998).

Guided by this theoretical orientation, this study focused on three arid regions which share a long tradition of pastoralism, but are different in many respects. Research in each region had to be autonomous, in order to gain both the social and environmental knowledge useful for developing drought contingency planning in that region, which may lead to action if adopted by households and authorities. A comparison of the three different

regions might theoretically lead to relevant conclusions with regard to the central theme of pastoralism and drought.

This study pays specific attention to rainwater harvesting as an aspect having potential to mitigate the effect of drought, by storing water that otherwise would run off. It can be a significant drought mitigation strategy at local level, since the principal resource involved – rainfall – is accessible at the household level. Pioneering research into rainwater harvesting agriculture was started in the Negev desert during the late 1950s by Evenari *et al.* (1971). The terminology of rainwater harvesting and system classification for crop production in relation to landscape geomorphology was addressed by Bruins *et al.* (1986), including examples of applications during the early 1980s in the Turkana District of Kenya. Reij *et al.* (1988) emphasised the necessity of socio-economic research for the successful implementation of rainwater harvesting in Africa. Remote sensing and geographic information systems (GIS) are important in site selection and the planning of runoff irrigation in the Sahel Zone of Africa (Tauer and Humborg, 1992). A very interesting case study of rainwater harvesting among settling Beja nomads in Eastern Sudan was carried out by Van Dijk (1995). The author succeeded admirably in integrating physical, social and economic elements in a comprehensive geographic approach.

This study, too, aims to integrate knowledge based on geo-scientific methods such as remote sensing, satellite images, aerial photographs, geographical information systems (GIS) and rainwater-harvesting evaluation with knowledge based on socio-economic, anthropological and environmental analysis of pastoralism and drought.

I.5 Methodology and elaboration of the research

I.5.1 Classification and comparison of aridity in the three project areas

Aridity is the principal constraint for livestock-raising in drylands. But how dry is dry? Can we compare the aridity in Turkana with that in Kajiado and in the Negev? The various definitions, terms and arid-zone boundaries cause problems in terms of comparability. Dietz (1987: 36), for example, found that the area designated as 'semi-arid' in a UNESCO map also covered part of the 'arid' zone in the Kenya Soil Survey map of 1982. In Kenya, potential evaporation data based on daily measurements in evaporation pans in meteorological stations has often been used in climatic classification and the establishment of agro-meteorological zones. For practical reasons we adopted this Kenyan approach, using potential evaporation data to calculate the ratio P/EP (participation/ evaporation

pan), in order to facilitate direct comparison between the degree of aridity in Turkana, Kajiado and the Negev.

An outstanding methodology to gauge both aridity and drought severity is the use of satellite images from NOAA's AVHRR sensor[3], which views the entire continent of Africa, including adjacent areas such as Israel and the Negev. For this study we used a 10-year database of satellite images from August 1981 to June 1991. Normalised Difference Vegetation Index (NDVI) values[4] were calculated separately for Turkana, Kajiado and the Negev, with the help of GIS (Geographical Information System) software. This enabled a direct comparison to be made between the three project areas, both in terms of average NDVI values and as specific values in time within the database period August 1981 to June 1991. Three NDVI figures were calculated per month, each averaging a ten-day period. Time-series analysis within the 10-year period also enabled an assessment of drought severity, as indicated by NDVI values, in comparison with meteorological rainfall and social data. Figure 3 presents two examples – dated mid February 1984 and mid August 1984, respectively – of NDVI images of Africa that include Israel and the Negev. The NDVI images are composites based on satellite pictures taken during a 10-day period in order to remove cloudiness as much as possible. The three circles on the NDVI images indicate the respective geographic location of the three project regions, *i.e.* Turkana, Kajiado and the Negev. The two NDVI images dramatically display the spatial extent and movement of the Intertropical Convergence Zone (ITC) during the year 1984, which was a severe drought year in Kenya, as well as in the Sahel.

I.5.2 Other methodologies used

An important part of the research involved questionnaire surveys among the Turkana, Maasai and Negev Bedouin with questions tailored to the specific human, pastoral, socio-economic and physical conditions in each area. Data collection in Turkana District concentrated on two

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3 NOAA = National Oceanic Atmospheric Administration (USA); AVHRR = Advanced Very High Resolution Radiometer.

4 The Normalised Difference Vegetation Index is a commonly used measure in remote sensing reflecting the vegetative cover on the land surface over wide areas. Vegetation strongly absorbs the red wavelengths of sunlight and reflects near-infrared wavelengths. NOAA satellites measure the intensity of the reflection from the Earth's surface in both the wavelength ranges. The NVDI is a measure of the difference in reflectance between these wavelength ranges. The NVDI takes values between -1 and 1, with values > 0.5 indicating dense vegetation and values < 0 reflecting no vegetation (source: www.pvis.net/pdfs/nvdi).

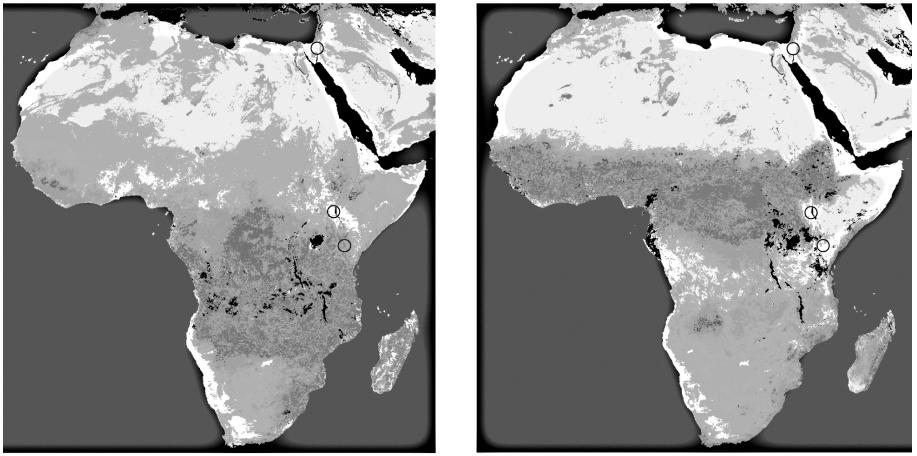

Figure 3 NDVI images of Africa and the Near East during 1984, which was a drought year in Kenya. Left image: February 1984; right image: August 1984.

administrative divisions, *i.e.* Turkwel and Kakuma. Using random sampling and the 1989 population census data (Kenya, 1994), a total of 294 households were selected for the questionnaire survey; 100 households in Turkwel division and 194 in Kakuma division (Table 2). In the Kajiado District, the Selengei, Meto and Olkinos group ranches were selected. The basic survey was conducted among 118 households in Selengei, 77 in Meto, and 96 in Olkinos.[5] In addition to the survey, observations were made, interviews and discussions with key persons were held and secondary sources were consulted. Rainwater-harvesting field trials were conducted in cooperation with the local Maasai in Olkinos, Selengei and Meto, focusing on both agricultural and pasture crops. Data has been analysed using Statistical Package for Social Sciences.

Table 2 Survey sample in Kenya and Israel

Area	Turkana District (Kenya)		Kajiado District (Kenya)			Negev (Israel)	Total
	Turkwel	Kakuma	Selengei	Meto	Olkinos		
No. of respondents	100	194	188	77	96	92	747

5 Only the Selengei results are included in this monograph.

In Israel a detailed questionnaire survey was conducted among 92 Bedouin households in various parts of the Negev, supplemented with an observational survey of Bedouin encampment and pastoral characteristics in the Negev Highlands. A detailed case study, combining weekly or bi-weekly herd monitoring and monthly spatial analyses with the use of Geographical Information Systems (GIS), was undertaken at Ezuz in the western-central Negev near the border with Egypt in 1997/98. In this area, sheep are kept for meat production and goats for milking to produce goat cheese – a novel development in the area. Livestock-raising at Kibbutz Sede Boker in the Negev Highlands, Israel, was also monitored and evaluated, focusing on herd and grazing management strategies and carrying capacity. Herd management by joint cooperation of a Bedouin household and the Kibbutz was followed on a weekly basis for almost a year. Specific plant density measurements were carried out of some rainwater-harvesting systems which have been built in the area of Kibbutz Sede Boker since the 1950s and which are used particularly for pastoralism.

II. Results

II.1 Characteristics of the pastoral systems in each study area

II.1.1 Turkana District

The Turkana regard themselves primarily as livestock breeders and have a pervasive livestock cultural ethos (Hogg, 1982), even though livestock-raising may be combined with small-scale farming, hunting, gathering and fishing. The household is the basic livestock-owning and breeding unit, but in reality there are multiple and overlapping rights to particular animals, with women and children also holding rights to own animals for subsistence (Toulmin, 1983). Inter-household livestock loans also exist, through which households receive animals from other households and gain usufruct rights, but no ownership. At the same time, the households may have some animals entrusted to others under similar terms.

Households try to keep the full range of livestock species: cattle, camels, donkeys, goats and sheep. This enables the households to take advantage of the different production characteristics of the species and to maximise on the exploitation. Most animals are held for subsistence, while small stock also function as currency and gift giving. The camel has become very important to the Turkana. It can lactate for up to 20 months, requires less water than cattle and can therefore forage in a wide area around a single water source. The Turkana, however, acquired the camels only in the last century and have not developed the same attachment to the animal as they have to cattle (Schwartz, 1985). Neither have livestock farmers paid due attention to the species. As a result, little is known about camel husbandry, management and health under the Turkana environment and the full production potential is therefore not fully achieved.

Due to the regular shortage of water and pasture, herders need to adopt nomadism in pursuit of such resources. Herd splitting is a widespread livestock management strategy, with camels, sheep and goats being kept in the plains and the cattle in the highlands. The movement is towards the highlands in the dry season and back to the lowlands in good wet seasons.

Customarily, range resources are communally utilised, but section membership seems to control access to pastures and water in varying degrees (McCabe, 1984; Norconsult, 1990). Particularly in times of stress, elders may deny outsiders access to local section grazing areas or extract a toll on livestock in exchange. In recent times, some herders have set aside limited areas of 1-3 kilometres in radius as individual reserved grazing land (Broche-Due and Storas, 1983). The Turkana pastoral system, particularly in the south and centre, also recognises the usufruct rights to riverine trees, claimed by individual families as a wet season grazing area. Water sources can be both communal (natural rivers, wells) and individual property (developed water sources such as dug wells).

It is not easy to acquire data on average household livestock holdings because the Turkana are usually reluctant to disclose livestock figures. However, the statistics available from aerial surveys indicate cyclical fluctuation in numbers over periods and a predominance of small stock over cattle and camels.

Little *et al.* (1988) indicate that the Turkana utilise all the animal species for blood, milk and meat. Donkey products are inferior, however, and are therefore consumed only by the very poor and those who are acutely hungry. Cattle milk yields, on average, between 1-1.2 litres per animal per day in the wet season, while yields fall to about 0.25 litres in the dry season. Camel yields range from more than 2 litres a day during the wet season to about 0.7 litres in the dry season. Average blood yields range from between 2-3 litres for cattle and camels and about 0.3 litres for small stock. According to De Gans (1980) goats and sheep yield between 0.5 and 0.25 litres of milk per day in the wet and dry seasons respectively. It is estimated that, given these low yields, individual household members would require five large stocks, on average, or its equivalent in small stock, to subsist on a pastoral diet. This is a figure some households do not always meet (Muller, 1989). Cultivation is therefore an important component of Turkana subsistence economy, with most Turkana women and girls cultivating sorghum. In addition, Turkana consume game meat and gather food products from the wild.

II.1.2 Kajiado District

Livestock-keeping is the main land use in Kajiado District. In 1988, the Ministry of Livestock enumerated 23,145 head of cattle, 7,106 sheep, 8,819 goats and 1,089 donkeys in Selengei group ranch, where the survey for this

study was carried out. This suggests a mean livestock ownership of 6 Tropical Livestock Units (TLU) per capita.[6]

Food security in a pastoral setting is to a large extent related to the ability of the herder to keep a large and varied enough herd for direct milk production – the Maasai staple food by choice – and to a lesser extent meat and blood. In addition, the sale of animal products such as milk, meat, manure, bones, hides and skins, enables the purchase of food products such as sugar and tea. For a long time, the Maasai were able to subsist entirely on the produce of their large herds, either directly (milk, meat, blood), or indirectly through lucrative barter for agricultural products. However, the number of stock units per capita has dwindled over the years.

Productivity levels are marked by intra- and inter-annual fluctuations between wet and dry seasons. Fodder and water availability fluctuate in time and space, forcing pastoralists to trek with their animals in search for new grazing grounds and water.

In addition to fulfilling subsistence needs, pastoralists need to maintain enough breeding animals for reproduction, as an insurance against losses due to diseases and droughts, and for social reasons such as dowries and assisting less well-off kinsmen. Consequently, the management of Maasai rangelands cannot solely be directed towards commercial output maximisation.

The risks involved mean herd owners need to engage in a whole range of stress-coping strategies against drought, diseases and predators. These can be both preventive (herd and resource management) and curative (change of food habits, change in herd and resource management and assistance from others). The most salient aspects of Maasai herd management are:

- keeping sufficiently large herds to accommodate anticipated losses;
- herd mobility;
- destocking through sales before and during a crisis and restocking when pasture is available again;
- managing a variety of livestock species requiring different ecological niches (grasses, shrubs, trees) and having distinct production characteristics (different periods of milk recovery and susceptibility to diseases);
- allocating animals to friends and relatives on specific loan arrangements, allowing the reclaiming of these animals in times of need.

6 One TLU is equivalent to 1.42 head of cattle or 10 hair sheep or goats.

Resource management involves the following aspects:
- setting aside certain dry-season areas on the basis of joint agreements with other households;
- refraining from using certain patches of land nearby the homesteads and using these fenced areas for calves and sick animals;
- making improvements in water availability through shallow wells and boreholes;
- food preservation through the drying of meat or storing of cheese;
- diversification of the household economy through engagement in rain-fed and irrigated cultivation, wage employment and commercial business;
- using bank accounts to store money for less fortunate days.

A curative strategy is to change food habits in times of stress. This includes reduced food intake, change in food intake (for instance eating less favoured parts of the animal such as hub, liver and tongue and increased blood consumption cooked or mixed with milk), hunting of antelopes and elands, and gathering of wild fruits, berries and roots.

Another stress-coping strategy is to change herd and resource management. For instance, elderly people take over livestock herding, while younger Maasai search for distant pastures. Other strategies of this kind include the use of dry-season areas, renting outside pastures or long distance trekking, the collection of grasses, tree pods and leaves as fodder, the reduced animal intake of drinking water and changes in milking practices to leave more milk for the calves.

Finally, pastoralists rely on their social support network in times of stress. Assistance is sought from friends and relatives and from relief programmes organised by the government and the church.

II.1.3 The Negev

Pastoralism is also by far the most predominant type of land use among the Bedouin households in the northern Negev. The most common land-holding size is in the range of 11-200 *dunam* (1.1-20 ha). More than 70% of the households own a tractor, while almost 30% mentioned the use of a combine for the grain harvest. This shows the significant contribution of agricultural activities to people's livelihoods, within a predominant pastoral livestock setting.

The Bedouin have gradually become part of a modern national economy, in which money is the principal "stock". In terms of household income, the contribution of pastoralism ranges from 10-90%, with 70% being the most frequent occurrence. The contribution of other sources such

as social security payments by the State of Israel may have been somewhat understated in the survey. Social security payments include child allowance (very significant in the large Bedouin families), unemployment, sickness and old-age. One Bedouin with a herd of 180 sheep acknowledged that 50% of his income came from social security payments.

Water supply is not a problem for the Negev Bedouin, even during severe drought, as virtually all of them receive water from the National Water Carrier System, both for their households and their livestock. Neither do the Negev Bedouin fully depend on natural pasture as the only food source for livestock, not even during the best rainy years. There is a symbiosis between livestock herding and cereal crop farming in the northern Negev and semi-arid regions to the north dating back to perhaps 5,000 years ago. Grazing of the wheat and barley stubble, after the grains have been harvested in around May time, has been a common practise in the region for thousands of years. However, the areas available today for free-range grazing have become much smaller, a trend also found among the Maasai. The decline of natural pasture availability as a food source for the herd, coupled with infrastructure development, better roads, transport, education and gradual integration into a modern economy, was accompanied by a change in the pastoral system from nomadic to a more sedentary form of livestock-raising. Virtually all Bedouin in the Negev can now be regarded as sedentary, though many livestock herds are mobile on a daily grazing cycle near the home and farther away from the home base during part of the year. The provision of education, which is compulsory by law, has changed manpower availability for shepherding to some extent, as children used to play a role in this field. Daughters are still the dominant group taking care of shepherding, but their numbers have declined during the past decade, while the number of hired male shepherds is on the increase. The decrease in the contribution from natural pasture as a food source for the herd was gradually compensated for by fodder imported from outside the region, which includes hay, straw and mixed cereal grains.

A detailed numerical analysis was made of the composition of livestock held by the Negev Bedouin, involving sheep, goats, camels, donkeys, cows, chickens and pigeons. In the case of virtually all households, sheep are the dominant category of animals, followed by goats and camels (Degen *et al.*, 2000). The fact that chickens and pigeons are kept by many households underlines the sedentary way of living of the Negev Bedouin. The dominant sheep herd size per household is in the range of 51-200, while the occurrence of larger herds has declined slightly. The dominant herd size of goats is 31-50. Camels have become more popular in recent years, perhaps

influenced by the lower labour demands of shepherding as compared to small stock. On average there are 2-4 camels per household. A camel is expensive, ranging in price from NIS 8,000 to 14,000 (US$ 2,000-3,400). Cattle are not very well suited to the arid Negev environment, hence the number of cows, if any, is generally limited to one or two per household. The overall number of donkeys is somewhat higher, as this type of animal is well suited to the environment. Most commonly, there are two donkeys per household. The animals are used for transport, often in conjunction with shepherding. Horses are rare and are kept only by a minority of households, with the norm being one horse per household. An increasing number of Bedouin households keep chickens, since both the eggs and the meat are used for home consumption and sales. The average number of chicken kept per household ranges between 11 and 40. Pigeons are also kept for meat production by a sizeable number of households with the average being 41-100 pigeons per household.

The study of pastoralism and the use of rainwater harvesting at Kibbutz Sede Boker since the 1950s highlights the difference between typical herd management common among the Bedouin and the changes the Kibbutz tried to develop. In traditional Bedouin management the ewes are raised on natural pasture with some extra food supplements for the production of lambs. The lambs are weaned for 6 to 7 months and then sold at the market once they have reached a weight of 35-45 kg. The advantages of this system are the minimal costs involved, as the ewes only receive food supplements in the event of severe pasture shortage. It is a good system to raise female lambs for growth, but production is relatively low.

The Kibbutz system of herd management focused on approximately two lambing seasons a year involving part of the herd, or one season a year in the event of a lack of pasture. Hormonal treatments and artificial insemination have been used to increase the number of lambs. The lamb is weaned for around 45 days after which it eats concentrated food after which full fattening takes place using mixed food. Some farmers want to wean their lambs after just 24 hours, transferring them to a so-called wet-nurse, which would generate economic savings, as the ewe does not need concentrated food for milk production. It would also enable her to become pregnant again in a shorter time period. One may, however, question the wisdom of stretching biological systems to the limit with artificial means. The number of lambs that died when taken away from the mothers so quickly, while the mother-milk was replaced with milk powder fed in bottles, was higher in the commercial pastoral system developed at Ezuz.

II.2 Drought conditions, vegetation and drought monitoring for pastoralists in the three study areas

A comparative aridity analysis of Turkana, Kajiado and the Negev was carried out by comparing aridity indexes and by using NOAA Advanced Very High Resolution Radiometer (AVHRR) satellite images.
Accepted climatic classification is based on precipitation (P) divided by evapotranspiration or evaporation pan (ETP or EP). Table 3 shows the P/ETP values for the three study areas. Arid regions *senso stricto* (a P/ETP value between 0.03 and 0.20) are suited for pastoralism, but not for rain-fed agriculture, which is feasible only in the semi-arid zone (P/ETP 0.20-0.50) or wetter regions. On the basis of these criteria, Turkana and the Negev can be classified as arid regions only suited for pastoralism, while some rain-fed agriculture would be feasible in Kajiado.

Table 3 Climatic comparison between the three study areas

	Precipitation (mm)	Evapotranspiration (mm)	P/EP aridity index
Lodwar, Turkana, Kenya	188	3.000	0.06
Kajiado town, Kajiado, Kenya	502	2.000	0.25
Sede Boker Campus, Negev, Israel	94	2.491	0.04

Natural vegetation is the basic resource base for arid-zone pastoralists in Turkana, Kajiado and the Negev. The investigated images of the NOAA AVHRR satellite for the period 1981-1991 clearly demonstrate that using the Normalised Difference Vegetation Index (NDVI) offers considerable potential for assessing differences in aridity between and within regions and monitoring vegetation resources. Through remote sensing by satellite, it is possible to monitor the state of the vegetation at a very detailed spatial-geographic scale. NDVI values appear to be useful indicators of drought impact on vegetation. Obviously, the impact on the vegetation does not automatically indicate the impact on the pastoralists and *vice versa* because vulnerability and socio-economic systems cannot be observed from a satellite. The 1984 drought in Kenya serves as an example in this respect.

In Kajiado District, the impact of drought in 1984 is shown most clearly by the depressed vegetation peak in May 1984 (NDVI = 0.23) as compared with "normal" conditions, for example in May 1985 (NDVI = 0.40). In Turkana, the impact of the 1984 drought on the vegetation was far more severe than in Kajiado. The last vegetation peak in Turkana before 1984 occurred in September 1983 and it took almost two years until the next

large vegetation peak in May 1985. In other words, there was no serious pasture-producing rainfall for about 20 months. An absolute low level of zero was measured for Turkana in November 1984, the lowest NDVI value in this study for the entire period 1981-1991. This accentuates the severity of the 1984 drought in Turkana, also indicated by the lowest numbers of cattle in the District for the period 1982-1992.

Based on calculations of the mean annual NDVI value of each year in each region for the period 1982-1990 (Table 4), the severity of the drought year 1984 in Turkana is spectacular (NDVI = 0.0556). As far as the Kajiado District is concerned, the drought year 1984 is not unusual since 1982, 1983 and 1984 have similar NDVI levels of 0.20, while the value for 1983 is even slightly lower than 1984. Table 4 shows a clear increase in vegetation (NDVI) during the period 1981-1990 in all three regions. These positive vegetation trends in three different dry regions with pastoral land use are rather reassuring in each individual case, considering the alarming expert opinions of desertification in pastoral areas, as expressed in the first edition of the World Atlas of Desertification (Middleton and Thomas, 1992, 1997). Remarkable vegetation rejuvenation followed the severe drought in Turkana in 1984. Consistent increases in NDVI vegetation values occurred in all three regions in the second half of the 1980s. On the basis of NDVI time-series analyses carried out in the framework of this study we therefore conclude that no desertification (in the sense of long-term loss of natural vegetation) occurred in the three studied pastoral regions during 1981-1991.

To sum up, we can conclude that the use of NDVI remote sensing by the NOAA AVHRR satellite can form an important basis for the assessment of drought impact on vegetation resources, including rain-fed agricultural crops. Such information is recommended as a vital element in the development of proactive drought contingency planning in Kenya. The NDVI remote sensing method can be used at the national level, and also in great detail at the district and division level. Obviously, rainfall data and socio-economic data also have to be included in impact evaluation.

NDVI data is also useful when comparing the differences in aridity between regions and monitoring changes in vegetation patterns. The highest peak of monthly NDVI values recorded in the period 1981-1991 for Turkana District ranges from 0.15 to 0.25, whereas for Kajiado District, monthly peak values range from 0.30 to 0.45. The lowest NDVI values are likewise much lower and of longer duration for Turkana District, as compared to the Kajiado District.

Table 4 Mean annual NDVI in Turkana, Kajiado and the Negev, 1982-1990

Year	Turkana Mean annual NDVI	Kajiado Mean annual NDVI	Negev Mean annual NDVI
1982	0.0669	0.2033	0.0650
1983	0.0847	0.2003	0.0881
1984	0.0556	0.2050	0.0794
1985	0.0814	0.2389	0.0647
1986	0.0764	0.2461	0.0783
1987	0.0994	0.2464	0.0939
1988	0.1072	0.2389	0.0917
1989	0.0953	0.2806	0.0892
1990	0.0903	0.2883	0.0933

Source: Calculations by Bruins (1999) based on the NOAA AVHRR NDVI archive (FAO, 1993) and GIS software.

Turkana District has a rather unpredictable pattern of higher and lower vegetation values. The month of May has the highest relative incidence of peak NDVI values, following the "long rains", but not on a regular basis. The "short rains" are hardly noticeable in Turkana. The lowest NDVI values in Turkana can occur at almost any time of the year. The NDVI values for the northern and central Negev region are rather similar to Turkana District. Both regions, therefore, have much lower pasture resources than Kajiado District.

The vegetation patterns in the Negev are more predictable than in Turkana. The annual green vegetation in the Negev, so important for pastoralists, reaches a climax in the wake of the winter rains in January, February and March. The dry season from May to October is always dry. The amplitude of vegetation changes in Turkana is larger than in the Negev. Peak NDVI values in Turkana may reach between 0.20 and 0.25, whereas in the combined area of the northern and central Negev, peak NDVI values are around 0.15. In Turkana, the effect of occasional strong tropical rains and continuous high temperatures may produce more pasture for certain periods of time than in the Negev. The lowest NDVI values are slightly lower for Turkana than for the Negev.

The long-term average NDVI value (1981-1991) of 0.08 is the same for Turkana and the Negev (north and central). Nevertheless, the Turkana environment is a bit harsher and more unpredictable for livestock rearing than the northern and central Negev region. But the inclusion of the hyper-arid southern Negev would have made the entire Negev region more extreme in average NDVI values than Turkana. Since the Bedouin nowadays do not use the very dry southern Negev for grazing, the area has

been left out of the project investigations. The long-term NDVI average for Kajiado is much higher: 0.24. It may therefore be concluded that the vegetation resource base for pastoralism in Kajiado District is about three times richer than in Turkana or the northern and central Negev region.

II.3 Drought impact and vulnerability in Turkana, Kajiado and the Negev

Turkana District and the Negev are more marginal in environmental terms as they have, in comparison to Kajiado, the lowest pasture resource base and the longest dry seasons. The latter district has a wetter, semi-arid climate and about three times more vegetation in NDVI index terms.

Turkana also suffers from geographical marginality as it is located at the periphery of Kenya, far away from the capital. Kajiado District, on the other hand, is located close to Nairobi. The Negev, too, has some typical periphery problems, but these are very small compared to Turkana, thanks to the relatively good road system, modern infrastructure and also the fact that Israel is a very small country. Turkana District alone is about three times as large as Israel, while Kajiado District is about the same size.

In terms of security, the best grazing grounds in Turkana are unsafe due to cattle-raiding in large areas along the borders with Ethiopia, Sudan, Uganda and also towards Pokot in the south-west (Rutten, 1989). The Negev also suffered periodically from insecurity, though the area has been quite safe since the late 1960s. Although the Bedouin lost grazing lands in the Arab-Israeli wars, their socio-economic situation has improved considerably during the last decades.

Turkana District and the Negev are in a more difficult and vulnerable position than Kajiado District, in terms of climate, pasture, security and periphery. Turkana has proved to be most vulnerable to drought. During the severe drought of 1979-1981, pastoral economic collapse was widespread in Turkana, as some 70,000-80,000 people lost most of their animals and depended largely on food relief to survive (Morris and Snow, 1983). Drought impact, hunger and food relief problems continue to play a role in Turkana today.

In 1998-2000, the Negev experienced the worst drought since 1962/63, which caused a sharp decline in the size of a natural herd of Nubian Ibex in the Central Negev Highlands from about 250 to only 50 animals. Notwithstanding the severity of the drought, the impact on the Bedouin pastoralists was small. Relatively few sheep died from the drought, despite the smaller areas in the Negev available for grazing.

The low vulnerability of the Bedouin pastoralists to drought as compared to the Turkana pastoralists is clearly related to the considerable

differences in infrastructure and socio-economic conditions, because the pasture resource base in both areas is similar in NDVI index terms. The main reasons for the low drought vulnerability among the Negev Bedouin are:

1. A modern water infrastructure and uninterrupted water supplies from the National Water Carrier System, despite the drought and severe water crisis in Israel.
2. A good road and transportation system.
3. Secure import of fodder into the Negev.
4. Sufficient cash among the Bedouin to buy supplementary food for the herd.
5. Easy access to markets to sell livestock in order to minimise expenses of supplementary food.
6. Social security payments to the Bedouin from the State of Israel.
7. Increased school education of the Bedouin and integration in the advanced regional economy of Israel.
8. Economic diversity: other sources of income to the Bedouin household besides pastoralism.

II.4 Indigenous approaches to drought and traditional drought-coping mechanisms

II.4.1 Turkana District

Turkana society had sophisticated mechanisms of managing resources, which minimise the risk of starvation (McCabe, 1984). This was partly through social institutions, seasonal grazing patterns, criss-crossing patterns of rights in livestock herds, cultivation of millet and sorghum especially by women, hunting and gathering and food processing and preservation.

There are factors that have exacerbated the onset and the severity of famine especially during drought years. These include cattle raids and general insecurity implying that nearly half the district is unsafe for normal grazing activities, while the remaining area is among the poorly endowed rangelands. Occurrences of livestock diseases and epidemics have often led to widespread losses of livestock in the district. A lot of cattle are lost in raids, while diseases and drought conditions are responsible for the loss of all kinds of animals.

Labour constraints also affect household production. This is especially so in households where males have out-migrated for employment and where children are engaged in schools. This has withdrawn labour

necessary in the nomadic movements and search for pastures, as women and the aged are considered to be less suited for such undertakings.

Social obligations of the households and individuals, which involve expenditure of livestock through exchanges as gifts in rituals and ceremonies of various types, represent a drain on a household's livestock holdings. However, they are also an important investment in terms of self-insurance against future uncertainties.

The Turkana traditionally employ water harvesting systems in their grain production. However, the traditional cultivation cannot be relied upon to feed the increasing population of the district. Several external interventions to boost rainwater harvesting exist in the region, such as the Turkana Rehabilitation Project (TRP) in the Lokitaung area. However, water-harvesting projects have been beset by a number of constraints (see Section II.6.1).

Thus, the Turkana traditionally had sophisticated drought-coping strategies, but increasing insecurity and internal social changes have negatively affected herd mobility and the amount of grazing space. These are perhaps the key elements in traditional pastoral drought management in arid areas. An apparent drought-induced collapse of the pastoral system in Turkana occurred as a result. The response of the outside world led to external interventions and food aid in Turkana District since the disastrous drought and famine of 1959-1961, which unfortunately led only to a temporary respite. In addition to the large number of rainwater-harvesting systems that were built in Turkana District (Section II.6.1), the interventions included relief food provision, the resettlement of people in irrigation schemes and an injection of capital into pastoralism through the training of para-vets, the facilitation of livestock marketing through auctions and the provision of livestock drugs. A number of interventions focused on the Lake Turkana fishing sector. These included the purchase of fishing boats and nets for Turkana fishermen, training and supervision of fish processing to increase its value and earnings, the construction of a fish-processing plant and landing bays and the empowerment of the monopolistic Turkana Fishermen Cooperative Society that was expected to provide collection and marketing of fish on behalf of the fishermen. The Italian government also sponsored an aqua-culture fish pond to replenish fish stocks in the Ferguson's Gulf, where most of the fish catches came from.

This heavy injection of external assistance, which was relatively capital intensive, has so far not provided the foundation of current or future survival during drought and famines, meaning they were not sustainable. This calls into question whether development thinking addresses the

sustainability of projects or the sustainability of aid. It appears that the latter is true for Turkana District. The implication is that sustainable livelihoods will have to come from multi-sectoral mobilisation of resources by the local community, with the assistance from external resources (see Box 1).

Box 1 The Lokitaung project

One of the best examples of drought contingency planning at a local level in Turkana was multi-sectoral, involving grain storage as well. NGOs encouraged the Turkana in the Lokitaung area to plan for future drought. The objective of this experiment was:

- to strengthen the capacity of the Turkana to initiate, manage and develop food security and
- to demonstrate that traditional pastoral institutions could serve as appropriate vehicles for development.

The construction of grain stores was advocated, including one special grain store to which all the garden owners who produce sorghum were obliged to contribute as a food reserve for use during the "hunger" season. They were also encouraged to establish cooperative multi-purpose stores that stocked grains and other essentials such as salt, sugar, seeds and improved dried skins for cash income. These stores were intended to assist the Turkana who live farther away from market centres in the acquisition of the basic commodities of life at a reasonable price. The cooperative stores would encourage the rise of Turkana shops in the countryside, by eliminating the middlemen and precipitate local profit sharing (Martin, 1990: 35).

This Lokitaung project was evaluated as a success in the long run for the following reasons:

1. There were clear benefits in the form of a higher grain production, food availability through storage, availability of essentials including seeds at local stores, better prices for livestock skins and flexibility for local people in need, as some essential commodities could be obtained through credit or exchange for small stock instead of cash.
2. The use of local leaders and committees for the mobilisation and distribution of food for work at the initial stages. Thus the garden owners were empowered to make decisions concerning their own activities, while the Intermediate Technology Development Group (ITDG) provided technical advice and Oxfam the funding. This development strategy gave the Turkana self-direction so essential in sustainability.
3. The NGO advisors persistently persuaded the Turkana to accept the principle that rainwater harvesting for agricultural purposes was an improvement on the traditional rain-fed sorghum gardens and should be viewed as supplemental to pastoralism (Cullis and Pacey, 1992: 75).

II.4.2 Kajiado District

The Maasai classification of drought into three categories shows the relevance of drought in their culture and experience, as well as the observed variability in terms of impact. The word *olameyu* may signify any dry spell or dry season without an indication of its impact, though some maintain it also has a bearing on the impact side. A second word *emboot* unambiguously describes a disastrous drought situation, as both livestock and wildlife die in large numbers due to lack of pasture. Finally, the word

emperi expresses the most severe type of drought with a long duration of over a year, affecting all of Maasai land. Water resources run dry and the soil becomes bereft of vegetation and dusty. People and livestock have to migrate over long distances to obtain water and pasture. Many animals perish on the way, littering the landscape with animal carcasses, and people's lives are also endangered. The term *emperi* is less known among young Maasai, as drought impact in recent years has been lessened by modern transport, international assistance and food relief.

Four severe drought periods during the 20th century were referred to using special names, as listed together with other drought years: 1925-27 *(Olameyu Loolonito)*, 1929, 1933-35 *(Olameyu Looloyik)*, 1938/39, 1943-46 *(Emboot Enkurma Nanyokie)*, 1953-56, 1960-61 *(Emboot Enkurma Sikito)*, 1963, 1973-76, 1979-80, 1984, 1994.

The Maasai pastoralists do not prepare themselves to cope with a major catastrophe. Nevertheless, the livelihood strategies applied are all geared towards providing enough resources for the household to make a living. The environmental setting of the Maasai is one of uncertainty and imbalance as opposed to the more stable ecosystems of humid regions. Hence Maasai pastoralists are coping with a series of risks that could, at any time, threaten the household economy which is centred mainly on the keeping of livestock in a semi-arid region. A lack of grazing, water scarcity, livestock diseases and predators all undermine the food base of the Maasai pastoralists.

Risk-reducing strategies include the keeping of different species of livestock (cattle and small stock), the crossbreeding of certain types of cattle in trying to mix hardiness with milk and/or meat production and the planned preservation of pasture areas. Households are not allowed to move into these areas until a certain date that has been mutually agreed upon. The Maasai attempt to make optimal use of the limited natural resources

These resources have dwindled in the last century, especially as a result of the loss of high potential grazing in Central Kenya during the British Colonial Period at the beginning of this century. After some decades of stability, the loss of dry season grazing areas continued in the wake of Kenya's independence, as the status of closed district was lost. The high-potential safe zones on the borders of the current pastures (*i.e.* Ngong, Loitokitok) and some crucial swamps (*e.g.* Amboseli) were added to the list of important grazing areas closed for Maasai pastoralism.

Currently, the influx of outsiders into Kajiado District as a result of the individualisation of land-ownership, coupled with the export of water from Kilimanjaro springs to neighbouring districts, further threaten the

availability of basic resources needed to feed a growing community. Improved roads, transport and the increased availability of food grains, as well as cheap animals (from Tanzania), compensate to some extent the dwindling areas of good (dry season) grazing pastures, due to the loss of Amboseli and Kimana swamps. The population increase, though less than was thought by the Ministry of Livestock and Agriculture, has also led to a relative dwindling of resources.

The Maasai livelihood and drought-coping strategies are primarily rotational and long-term. The sequence of dry and humid periods is known and to some degree predictable and regular. The Maasai adapt to these seasons by practising their long-term strategies mentioned above. The main aim is to try to save as many animals as possible during the drought periods. In order to reach this goal, households invest labour and finances in shifting the animals, build temporary houses, fetch and transport water, move animals during the night and increasingly buy grazing land.

Whether the strategy is successful only becomes clear at the time of new rains and the re-vegetation of the pastures. Still, many Maasai try to predict the onset of a drought and the severity of it. A distinction is made between the dry spell *(olameyu)*, serious drought *(emboot)* and extreme drought *(emperi)*. The movement of stars *(kiliken/olikirrai)* and pleiades *(inkokua)* is consulted primarily by Selengei Maasai. The behaviour of animals is also important. A few also consult special ritual experts.

In Selengei group ranch there was no widespread specific preparation by Maasai households for possible extreme drought. With regard to herd management, only one out of five to seven respondents sold cattle during the droughts of 1984 and 1994. The money was mainly used to buy food. One to eight households stored money in a bank account during these years. Forage collection for livestock is mainly practised during a drought. *Isagararam* pods, *erikaru* grasses, bird nests and the leaves of *oseki* and *oltimigoni* are used as extra forage. Hay, maize stalks and napier grass are hardly added. Human food is also stored, yet traditional methods (sour milk, cheese, and dried meat and meat preserved in fat) are said to be on the decline. Nowadays the wealthy Maasai, in particular, store maize which is mostly purchased in the April-June period. However, this practice is still not widespread. A lack of good storage facilities is one of the most important causes. Transport is another problem. However, the gradually improving infrastructure of Kajiado District and the increase in the number of shops have minimised this problem and also, to some extent, the need to store food at home. It is thought that these shops also minimise the need to prepare traditional foods consumed in the past during the dry

season (*e.g.* dried meat). The Maasai food base is somehow secured as long as supply to these shops is guaranteed at reasonable prices, but also because Maasai cash incomes have increased as a result of increasing economic diversity. It is good to keep in mind that the illegal influx of maize from Tanzania also plays a role in this respect. It is to be expected that this will continue, unless prices in Tanzania increase more than those in Kenya. The Kenyan authorities do not seem to be willing to stop this practice, which probably is to the benefit of the inhabitants of Kajiado District and beyond.

The Maasai also change their food habits during periods of drought. Slightly more than 50% of the Selengei Maasai diet consists, on average, of pure pastoral foods (milk, meat, blood). In dry seasons the contribution of pastoral foods may drop to as little as 10%, as happened in 1994. In most long dry spells maize-meal constitutes 50-65% of the total food intake and is therefore the major food source within the Maasai diet. Food aid (25%) was especially important during the 1994 drought. Since the 1960s, food aid has been provided free at 10-15 year intervals, until recently, *i.e.* the 1994-6 drought period. Since then the Maasai were made to work for food (FFW). Initial resistance was broken soon. The development of FFW projects (*e.g.* clearing roads, fencing compounds and digging water pans) as a united community in return for food was highly appreciated, though it was considered to be extremely tiresome and time-consuming work. Moreover, some people complained about the yellow maize provided and the breakdown of the traditional social obligations and rules. Some of the men, in particular, considered the work for food practised by their wives to be a good reason to indulge in relaxation and drunkenness.

FFW and food relief have now become part of the drought recovery strategies of the Maasai pastoralists. The selling of hides and skins and the use of a social network *(ewali)* to acquire livestock (exchanging, borrowing, free gifts) all play a role in this process of recovery. Food aid provided by outsiders seems to weaken the traditional Maasai social system. In any case it reduces the need to sell animals. In the end it depends how well the herds are able to survive extreme drought and how fast a recovery is made.

During extreme drought the Maasai may move out as far as neighbouring districts or Tanzania. Grazing is strictly regulated in Selengei group ranch especially since 1978. Dry season grazing areas are set aside and the households are not allowed to move into these areas until a certain date that is mutually agreed upon. Two more shifts are sometimes made in search of grass and water. In addition to this herd management practice, the availability and intake of resources (grass, water) are manipulated.

Water and grazing material are collected and transported. Increasingly large sums of money are being invested in providing livestock with green pastures by way of hiring access to individual ranches. Others take a risk and move into disease-infected hilly areas (*e.g.* Chyulu hills). Though vaccination seems to be on the increase, especially among young Selengei Maasai, this does not guarantee that all livestock diseases can be prevented in this way. For this reason, some prefer to stay around in the group ranch as Selengei is a relatively disease-free zone. When the new rains come, they could be the lucky survivors. Though droughts are often blamed for the loss of cattle, it is especially during the first week after the rains that the drought-weakened cows die. The sudden coldness is a major livestock killer.

Selengei group ranch members use a wide range of water sources. Boreholes, wells and the recently established Noolturesh pipeline are the most important water sources during the dry season. Unlike other parts of Kajiado District, the Selengei pastoralists have not yet started the construction of man-made pans to catch rainwater on a large scale. The subdivision of the ranch into individual ranches might change this drastically as witnessed in neighbouring group ranches.

In principle, the Maasai of Selengei have a positive attitude to the idea of rainwater harvesting for pasture improvement. Yet, those in favour as well as those opposing this idea refer to the need to change land tenure regulations before such an investment can be made. Moreover, most see it as a minor contribution only. At the same time they acknowledge that a lack of knowledge on how to construct these water-harvesting structures, as well as financial problems, are the main socio-economic constraints to water harvesting in the Selengei region at this moment.

It is expected that the growth of the population and the call for subdivision of the group ranch, in spite of money offered by KWS to prevent this, will indeed bring forward an explosion in the implementation of rainwater-harvesting techniques in the decade to come. The trial plot near Lenkisim church showed the local residents that napier grass and maize can be grown successfully with run-off water collected in a field, surrounded on three sides by a low earthen bund. This might have set an example for many to copy in the near future.

II.4.3 The Negev

There are interesting similarities and differences when the Negev Bedouin are compared with the Turkana and Maasai pastoralists. We studied indigenous methods of drought forecasting among the Bedouin. Though the methods employed by the Bedouin are fewer and different from those

employed by the Maasai, both pastoral groups considered it important to try to find out in advance about the possible occurrence of drought, as it may assist preparedness planning in the face of a potentially dangerous natural hazard. An interesting similarity between both the Maasai and the Bedouin is the observation of the position of a particular group of stars, the Pleiades, which are compared with a bunch of grapes by the Bedouin.

A survey was also made to study the collective memory concerning past drought years among the Bedouin. Here, another interesting similarity was found with the Maasai since the Bedouin also assigned special names to certain drought years. The earliest years mentioned are 1914 and 1917 *(Al-Gardeh)*. The other drought years that were allocated a special name are 1927 *(Sanat Al-Garad)* and 1947 *(Sanat Hamra Talak)*. Other exceptional drought years that were remembered but were not assigned a special name include 1931, 1955, 1962/63 and 1990/91.

The drought of 1998/99 was the most severe one in the Negev since 1962/63. Most Bedouin considered this drought very severe and a sizeable proportion regarded the drought as the worst they had ever experienced. One of the most important results of this study is the fact that the impact of the severe 1998/99 drought on the Bedouin has been rather small. Many wild grazing animals died as a result of the drought, due to lack of pasture, but only a few sheep died in the Bedouin herds despite the smaller areas in the Negev available for grazing. Purchased fodder, which includes hay, straw and mixed cereal grains, partly replaced natural pasture in the Negev, while water became available from the National Water Carrier System. The government made sure that livestock fodder was imported. The national resource base became too small as the drought had affected the entire country of Israel. Most Bedouin households had sufficient cash to buy extra supplementary fodder. Those who experienced problems sold part of the herd to reduce expenditure. To summarise, the main impact of drought on the Negev Bedouin pastoralists today is financial, as expenditures for purchased fodder increased by factors of between two and four.

The above shows that the vulnerability of arid-zone pastoralists to drought decreases as infrastructural and socio-economic development continues. As education improves and job opportunities outside pastoralism and agriculture increase, so the households' income diversity increases while changes in the pastoral system reduce their drought vulnerability. Such a development across the board is gradual. It cannot be brought about merely by outside intervention and development projects, though these may be important stimulators. The provision of social security payments by the State of Israel to its citizens, including the Negev Bedouin, forms an

important security net of cash, during drought years as well. All in all, the developments in the Negev may provide useful ideas for the development of integrated drought contingency planning in Turkana and Kajiado (Kenya) targeted to arid-zone pastoralists.

II.5 Significance of rainwater harvesting in Turkana, Kajiado and the Negev

II.5.1 Turkana District

Following the 1979/80 famine and the establishment of the Turkana Rehabilitation Programme (TRP) with funding from the European Economic Commission and the Government of the Netherlands, a large number of rainwater-harvesting systems were built in Turkana. The TRP had constructed more than 4 million micro catchments in Turkana by 1993, which is a staggering amount. In terms of performance and maintenance, 71% of the micro catchments functioned while 29% had become non-functional. With regard to other rainwater-harvesting systems, "only" 729 trapezoidal bunds[7] were built, but these had a much higher functionality rate (90%) and only 10% failure. A third system involved "only" 571 semi-circular bunds with a 74% success rate and 26% failure (Department of Agriculture, Lodwar, 1993: 39).

NGOs built similar numbers of rainwater-harvesting systems in Kakuma division, but here no functionality data was available. Early efforts via rainwater-harvesting projects by the Salvation Army project in Lokitaung division had a beneficial demonstration effect thanks to the prevalence of good sites at which traditional gardens were already located and relatively good rainfall.

The huge numbers of micro catchments can be explained by a number of advantages this system has, such as fewer engineering problems, less earth moving and lower costs, easy maintenance and efficient runoff production – if there is rainfall.

In social terms and as far as local perception is concerned, the Lokitaung project in the 1970s showed that the participants were sceptical of the success of the projects and preferred boreholes with irrigation from groundwater, citing erratic and unreliable rainfall as a bottleneck to water harvesting. This local perception may be partly correct for the drier parts

[7] A trapezoidal bund consists of a straight base bund parallel to the contour lines at a position in the landscape suitable for rainwater harvesting. Two side bunds extend upslope from the base bund at an angle of approximately 135°. The base bund is usually 40 m long. The water impounded by the trapezoidal bund is absorbed gradually into the subsurface soil. Crops are planted within the area enclosed by the trapezoidal bund.

of Turkana, because no rainfall means no rainwater harvesting either. Groundwater development may be a much wiser approach, perhaps in combination with rainwater harvesting, if such systems can be developed and maintained in a sustainable manner by the local population, assisted by outsiders.

The Lokitaung project also indicated that the motivation for families to participate was the immediate and direct gains in terms of obtaining food for work and cash employment. Nevertheless, successes in rainwater-harvesting projects were accomplished through a wise social approach, involving local leaders and committees for mobilisation and for distribution of food for work. Traditional garden owners were empowered to make decisions concerning their own activities, which gave the Turkana the self-direction so essential for sustainability.

Moreover, the NGO advisors persuaded the Turkana to accept the principle that rainwater harvesting for agricultural purposes was an improvement on the traditional rain-fed sorghum gardens and should be viewed as supplemental to pastoralism, while the two forms of livelihood were not alternatives (Cullis and Pacey, 1992: 75).

Though the continued use of these systems was found to be above 70% and the effect meritorious, rainwater harvesting alone seems incapable of bringing about a "new deal" of sustainability and self-sufficiency for the Turkana pastoralists. Nevertheless, further improvement in rainwater-harvesting development should be pursued, taking into consideration the following factors:

1. The livestock sector is and should remain the principal economic pillar of Turkana society. Development and improved education will only slowly and gradually allow for jobs in sophisticated groundwater irrigation, services and industry.
2. There is need to train the people in effective methods of disease and pest control in sorghum production.
3. Agricultural production in rainwater-harvesting systems in Turkana has been rather poor, while rates of adoption and sustainability are relatively low. New efforts would require demonstration projects that show and bring about higher yields and should be aimed at building confidence among the local participants.
4. Unlike in livestock management, there is no ethos of communal cooperation in agricultural cultivation, as the Turkana used traditional gardens only within the household. Communal participation has also been problematic in water-harvesting projects, due to lack of a social tradition.

II.5.2 Kajiado District

The study in the Selengei area provided two elements concerning rainwater harvesting among the Maasai:

1. Traditionally only the Iloogolala subsection was active in the construction of water-harvesting pans for drinking water. This group was almost wiped out in the 19th century, but found refuge among other Maasai groups. Nowadays, the Maasai remember the Iloogolala especially for their water-harvesting structures. A new age group would not be circumcised unless they showed their "cohesivity" by producing a water well or pan that could satisfy both men and animals. Even today these water-harvesting pans can be found in the Selengei area, still in use.
2. Other Maasai in the Selengei region do not yet engage in rainwater harvesting but rely on boreholes, wells and the recently established Noolturesh pipeline. Lack of knowledge and money are given as reasons. However, future subdivision of the group ranch and privatisation of land is expected to cause a sharp rise in rainwater harvesting. The semi-arid climate in Kajiado District will undoubtedly generate more and more frequent runoff as compared to Turkana. The two dominant constraints for Selengei pastoralists to develop water-harvesting structures today are lack of knowledge and lack of money.

The rainwater-harvesting field trials gave a significant number of valuable data concerning actual yields in micro catchments or somewhat larger systems at three different sites at Kajiado District, near Olkinos, Lenkisim (Selengei) and Meto. The exposure of the local population to the trials was important, while their reactions gave some interesting insights. Maize, beans and napier grass as a fodder crop were sown and the rainfall and runoff monitored during a three-year period from 1995 to 1997.

At the Olkinos site, maize grown during the long rainy season showed large variations in annual yield in response to different rainfall and runoff conditions in each of the respective long rainy seasons. Maize yields in the runoff-receiving fields varied from a low of 1.158 kg/hectare to a high of 4,084 kg/hectare. Yields in the control plot ranged from a low of 1,135 kg/hectare to a high of 3,574 kg/hectare. Beans grown during the short rainy season of 1995 showed a dramatic increase in fields that received runoff water, 259 kg/hectare as compared to only 42 kg/hectare in the control plot.

The usefulness of micro catchments in this semi-arid area with heavy clay soils is hampered by occasional waterlogging. Considerable advantages of more moisture in a dry year may become a partial disadvantage in a wet year due to excess runoff water, waterlogging and reduced yields as a

result. Nevertheless, there was some advantage of added runoff in wet years that showed up at the end of the growing season, as larger maize grains were produced, which the local farmers kept as seed stock for planting in the following year. Ndaraiya suggested that the problem of excess water in the micro catchments during wet years could be managed by the farmer, if he would make openings in the bunds to drain the water.

At the Lenkisim site, which is located in one of the driest parts of Kajiado District, Ndaraiya managed to grow maize in the area for the first time, to the excitement of local Maasai school children. They had never seen this before, could not wait for the harvest and ate the soft green maize before it had ripened. Napier grass, which is an important fodder crop, was also grown successfully. The effect of added runoff on natural pasture was also dramatic, as the lush pasture was eagerly grazed by the Maasai herd. The demonstration effect of runoff use at the Lenkisim site was significant. But even here, possible excess of runoff water may occur in wet years, which would require some drainage management, as described above.

At the Meto site the first runoff system linked to a small stream channel (liman system, Bruins *et al.*, 1986) did not function and was changed for a micro catchment system, as recommended by Bruins. A good maize yield was obtained in 1997, but here too excess water in the rainwater-harvesting fields caused problems that reduced yields. Nevertheless, larger maize grains were produced in the fields with runoff water.

The rapidly changing status of land tenure in Kajiado District from communal pasture lands to group ranches and privately owned land seems to encourage resource management intensification. As free-range grazing becomes more limited, mixed farming with production of fodder for livestock may become more attractive in this semi-arid district. Napier grass production, for example, could be relevant in such a context. Rainwater is already harvested as drinking water by people on their own initiative in cisterns near their homes as well as in large pits dug in the heavy clay soils, where the soil becomes impermeable and runoff water may remain for a considerable period (water pans). In some cases, such runoff water is even pumped to agricultural fields and used as a water source for modern irrigation farming.

Finally, at the Meto site, we questioned the local Maasai owner of the land, who in his own lifetime underwent the immense cultural change from a semi-nomadic pastoralist, who would not work the soil, to become a "mixed farmer". He made it very clear that with the changes in land tenure there was no way back to the old extensive system of semi-nomadic herding. He clearly appreciated the potential of rainwater harvesting, in

which he himself was engaged quite actively. Concerning the growing of maize, he pointed out the usefulness of having part of the crop as food, the grains, with the rest of the plant serving as livestock fodder. He even said optimistically: "Perhaps the new system may be better than the old one."

II.5.3 The Negev

Rainwater harvesting was already practised in the Central Negev 3,000 years ago. Though the present Bedouin tribes came into the area during the last 200 years, they use the ancient rainwater-harvesting fields for auxiliary agriculture. However, cisterns are hardly used for drinking water, as the National Water Carrier System completed in 1964 brings piped water from the wetter centre and north of Israel into the northern and central Negev as far south as the town of Mitspe Ramon. Moreover, this has become the main water source for the Bedouin, who ceased their nomadic existence. Nevertheless, rainwater is harvested by Bedouin to grow vegetables, fruit trees and cereal crops in terraced fields in the Central Negev and in fields with earthen dams built since 1948 in the northern Negev.

On the other hand, increased sedentary living by the Bedouin in the northern Negev, coupled with the availability of bulldozers, resulted in the construction of earthen check-dams *(sadd)* in special fields situated in valleys. These rainwater-harvesting systems were built by the Bedouin in the northern Negev on their own initiative after 1948, following sedentarisation and reduced access to grazing lands. Vegetables, fruit trees, olives and cereal crops are grown with the help of runoff water. The functioning of these systems during drought years seems mixed, according to the survey replies. This is understandable, as catchment systems and average rainfall amounts vary and some systems may continue to function in drought years, while others may fail. These fields with a *sadd* provide extra pasture in drought years, but pasture quantities are limited, due to their inherently small scale.

The Bedouin in the Central Negev Highlands also receive drinking water from the National Water Carrier System. They use ancient terraced fields that receive runoff for auxiliary agriculture, usually for added pasture. A significant number of these ancient systems were apparently built or rejuvenated through central planning and government assistance in the time of the Byzantine Empire. Though the Bedouin have recently acquired a taste for agriculture (Kressel *et al.*, 1991), large communal planning for the construction of a rainwater-harvesting system is clearly not in their tradition. Here, some comparison can be made with the Turkana

and Maasai. Construction or rejuvenation of rainwater-harvesting systems for agriculture is occasionally carried out on an individual basis by a certain household.

Paradoxically, the modern water system in Israel has been plagued by a non-sustainable form of management through over-pumping of the water resources that include Lake Kinneret, the Coastal Aquifer and Mountain Aquifer (Bruins, 1993, 1996, 1999, 2000a). Water is becoming much more expensive and the scarcity of water has led to a renewal of rainwater harvesting in the Negev, to the recharging of groundwater and the storage of significant quantities of surface water. The increased price of water, which is a sound development, may induce an increase in rainwater harvesting, as water quotas to agriculture were severely slashed in the last few years. Both historical evidence and modern experiments by Kibbutz Sede Boker clearly show the potential of rainwater harvesting. Its actual use and usefulness depend on a variety of factors in a modern economy, in which supplementary feeding to livestock has become the standard, among the Bedouin as well.

II.6 Conclusions: drought vulnerability *vis-à-vis* economic development

The three arid-zone population groups studied – the Turkana, Maasai and Negev Bedouin – are mainly livestock breeders who depend on rangeland for their survival. Being regularly faced with a shortage of water and pasture they all used to practise nomadism in pursuit of these resources. All groups nowadays supplement their subsistence needs by farming. The Turkana also hunt and collect food products from the wild, while the Maasai are also engaged in waged employment and commercial business. The Negev Bedouin have more diversified income sources and receive a substantial part of their income from social security payments from the State of Israel.

A comparative assessment of their resource base on the basis of a 10 year calculated average (1981-1991) NDVI value shows that Turkana District and the northern and central Negev have a similar NDVI of 0.08. The 10 year average NDVI value for Kajiado District is much higher, being 0.24. Therefore, the vegetation resource base for pastoralism in Kajiado is about three times higher than in Turkana and the Negev.

Although the pasture resource base in Turkana and the Negev are similar in NDVI terms, the Bedouin pastoralists are nowadays much less vulnerable to drought as a result of infrastructural and socio-economic development, coupled with incremental changes in the Bedouin system of livestock-raising. This shows that a more developed economy with

diversified sources of income besides pastoralism, coupled with a modern water and road infrastructure, is an important basis for reducing vulnerability to drought. In addition, the social security system provided by the State of Israel is a source of cash, enabling even the poorest Bedouin pastoralists to purchase basic commodities and fodder for the herd during a drought.

A detailed NDVI evaluation and GIS calculations of NOAA AVHRR satellite images for the period 1981-1991 contests the view that there is desertification in terms of natural vegetation decline in the project areas. On the contrary, a clear increase in vegetation activity (NDVI) during the period 1981-1990 was found in all three pastoral regions studied.

Notwithstanding, the pastoralists are regularly faced with the consequences of drought. They all have developed strategies to cope with these consequences. For the Turkana the drought-coping strategies included social networks, seasonal growing patterns, criss-crossing patterns of rights in livestock herds, cultivation of millet and sorghum, hunting and gathering as well as the processing and preservation of food. However, increasing insecurity and internal social changes as a result of out-migration and increasing school attendance by children have had a negative influence on traditional pastoral drought management. An apparent collapse of the old pastoral systems occurred as a result, inducing external interventions and food aid which only brought temporal relief.

Drought-coping and risk-reducing strategies among the Maasai include herd mobility, the reduction of livestock numbers through sales or the temporary allocation of livestock to friends and relatives, the keeping of different livestock species, diversification of the household economy, food preservation and a change in food habits and the formation of reserves (money, grazing land, food and water). Food-for-work projects and food relief have become part of the drought recovery strategies.

The Negev Bedouin are less susceptible to drought since they receive water from the National Water Carrier System and practise a more sedentary form of pastoralism, which is intrinsically linked to cereal crop farming and the use of purchased fodder.

The Turkana traditionally used water harvesting techniques in grain production. Among the Maasai, rainwater harvesting traditionally did not play an important role in their drought-coping strategies, with the exception of the Iloogalala tribe which constructed water-harvesting pans for drinking water. Following the 1979/1980 famine, several foreign donors introduced water-harvesting systems in the Turkana District. Rates of adoption are poor, however, mainly due to a lack of social tradition in

communal participation. Some rainwater-harvesting trials have been conducted among the Maasai. They practise little water harvesting as yet, but it is expected that with increasing trends towards the formation of group ranches and the privatisation of land, mixed farming and rainwater harvesting will become more attractive.

In the central Negev, rainwater harvesting was used as long as 3,000 years ago. These practices are being revived now that water is becoming increasingly scarce and expensive.

Finally we conclude that pastoral adaptation and more diverse economic development have to come from within, but that outside help is significant. Drought vulnerability among pastoral societies declines with increasing economic diversity and a better infrastructure. However, drought remains a hazard in every society, even if the impact becomes less life threatening. Rainwater harvesting always remains a prudent part of water resource management in arid zones, having a drought-mitigating potential for pastoralists. Integrated drought contingency planning is a must in Kenya, as well as in Israel, because food availability on the world market cannot be taken for granted. Large-scale food shortages and famine in the 21st century are quite possible (Bruins, 2000c). Development and infrastructure improvements raise the threshold of drought vulnerability but, paradoxically, cannot lead to invulnerability in a complex world, in which most countries require food-grain imports, while world food reserves are very small.

III. Discussion

III.1 Scientific relevance

This research project has been characterised by an interdisciplinary approach of geographical and social sciences, an essential requirement for the subject of drought planning and rainwater harvesting for arid-zone pastoralists in Turkana, Kajiado (Kenya) and the Negev (Israel). Both drought and rainwater harvesting have physical, spatial and social dimensions. The major findings of this study reflect the above approach. The relevance of these findings is twofold. First, the study made clear that the use of Normalised Difference Vegetation Index data from satellites is very useful for measuring the degree of vegetation-cover activity between and within regions for the purpose of comparative pasture-base analysis, drought impact and desertification assessment. Botanists and range specialists could not have produced a comparable methodology as provided by the satellite "eye", which "sees" the three distant project regions simultaneously in one view. Moreover, viewing is continuous through time, enabling time-series analysis of changes in NDVI vegetation data. These are very relevant scientific data that could not have been obtained from field surveys on the ground. Second, the study generated data on drought management and rainwater harvesting in the three study areas, thereby providing insight into drought preparedness and the needs for mitigation planning.

III.2 Recommendations for further research

The general recommendations for Kenya are as follows:

1. Investigate possible institutional and organisational set-ups for integrated drought contingency planning at national and district levels.
2. Make an inventory of specific measures that can be taken for preparedness planning, mitigation planning and response planning in the context of integrated drought contingency planning.
3. Evaluate the potential of rainwater harvesting in each district.

4. Evaluate groundwater resources in each district, as well as the safe yields that may be extracted annually under sustainable long-term management.
5. Evaluate the potential of fodder production in each district and division, including perennial species in an agro-forestry context, as well as commercial fodder development, perhaps as a by-product of agriculture.

The following are specific recommendations for research in Turkana District:

1. Carry out applied research aimed at a suitable curriculum for the setting up of a local school of development studies and management in Lodwar (Turkana), under the aegis of Moi University and the School of Social, Cultural and Development Studies. The aim is to educate and train local Turkana concerning the options of development and the appropriate management of development projects. Such a programme can also provide educated local manpower for NGOs and other external organisations, so that these can function under local Turkana leadership, which is extremely important for incremental development that can be sustained.
2. Investigate possible institutional and organisational set-ups for integrated drought contingency planning at district and division levels.
3. Draw up an inventory of specific measures that can be taken for preparedness, mitigation and response planning in the context of integrated drought contingency planning at the division level.
4. Evaluate the potential of rainwater harvesting and detailed analysis of reasons for success and failure of specific individual or communal cases of rainwater harvesting in each division.
5. Evaluate groundwater resources in each division, as well as the safe yields that may be extracted annually under sustainable long-term management.
6. Evaluate the potential of fodder production in each division, as well as an assessment for its commercial development, perhaps as a by-product of agriculture.

As far as the Kajiado District is concerned, we recommend research into:

1. The functioning of, and lessons learnt from, famine relief at local and district level.
2. Options for shallow wells improvement in the southern part of the Selengei group ranch and the desirability of deepening natural pans.

3. Ways to prevent animals dying in the first week after the rains begin and when they move into tick-ridden dry season grazing areas.
4. Upcoming schemes of Maasai cooperatives that sell, buy and store the profits in a bank account to be used for the needy, assisting each other in providing labour to construct water-harvesting infrastructure.
5. Options to ensure guaranteed mobility.
6. Options to improve conservation and marketing of hides and skins.
7. The pros and cons of improved storage facilities and the need for building either individual or community stores, using both underground and above-ground designs as recently developed among the Borana (see Blowfield and Donaldson, 1994).
8. Economic and sustainable ways to eradicate unpalatable grasses and shrubs.
9. Ways to allow and ensure participation by the local people.
10. The trade effect of Maasai pastoralists starting to cultivate maize themselves.
11. The use and importance of trees, shrubs and grasses.

As regards the Negev we recommend the following:

1. Research on ancient terraced *wadi* systems, as part of the restoration and reconstruction of the historical landscape in the Central Negev Highlands.
2. Research on the *sadd* rainwater-harvesting system used by the Bedouin in the northern Negev.
3. An investigation of the feeding relationship between natural pasture and purchased fodder under more sedentary Bedouin pastoral management in the northern Negev and Central Negev Highlands.
4. Research on the contribution of restored rainwater-harvesting systems in the Central Negev Highlands to increase cereal grains, stubble and pasture in more sedentary pastoral management.
5. Production and marketing research concerning high-quality goat cheese in the Negev, including an analysis of the potential local market and export.
6. Production and marketing research, concerning local and export market opportunities for naturally grown sheep and goat meat, produced without hormones on natural pasture and supplementary feeding limited to hay, straw and mixed grains (no use of chicken excrements in feed, for example).
7. An investigation of the potential use of local groundwater in the Negev, in conjunction with desalination, in order to partially decentralise water

supply in the region for superior resource management and contingency planning.

III.3 Practical applicability

This study demonstrated the usefulness of the NOAA AVHRR satellite for drought monitoring on an international, national and district scale. Normalised Difference Vegetation Index (NDVI) values were found to be a useful indicator of drought impact on vegetation. The relevance of this relates to the interface of vegetation data and governance. Proactive planning by governments with respect to drought mitigation and drought response for pastoralists requires pre-defined numerical indicators of drought impact on the vegetation. NDVI analyses can, at little cost, provide a detailed numerical time series of the state of the vegetation at regional, national and provincial levels.

This study also provides insight into the elements of drought contingency planning. Such planning needs to integrate preparedness, mitigation and response planning at various levels of severity, from a mild crisis to a disaster (Bruins, 2000b, 2000c). Rainwater harvesting is an example of preparedness and mitigation planning, as the presence of such systems can make a local pastoral household or area better prepared to mitigate drought by managing the reduced input of rainwater more intensively. If the rains fail below a certain threshold, however, additional measures are needed, as we will outline in the next part of this monograph.

IV. Recommendations

IV.1 Development of integrated drought contingency planning in Kenya

Drought contingency planning is a complicated task, which requires both knowledge and the necessary institutional set-up to develop sound planning in a governmental framework that can lead to successful action. In accordance with a suggestion by Wilhite (1993, 2000b, 2001), a Drought Task Force could be formed to prepare integrated drought contingency planning. Such a task force would be composed of scientists, who collectively have the required knowledge, and decision-makers, who can work out plans that lead to action in an administrative governmental framework. For Kenya, it might be an idea to integrate drought contingency planning at national and district levels. The following are the recommended activities, with a special focus on pastoralists:

1. Real-time drought monitoring on a national and district scale.
2. Criteria for defining and declaring a drought at a national level and within each district.
3. Special comprehensive legislation for drought conditions that become valid when and where a drought has been declared.
4. The development of an improved water infrastructure in the countryside within the framework of sustainable water resource management.
5. The development of rainwater harvesting for households, livestock and supplementary agriculture.
6. The formation and maintenance of strategic reserves of food grains in a buffering mechanism, in order to prevent undesired interaction with local production and trade, and to prevent manipulation.
7. The systematic development of wastewater treatment facilities in towns and cities in development projects supported by the international community, to provide treated wastewater to urban and peri-urban farmers, which is an excellent strategy for local irrigated food production also during times of drought.
8. The stimulation of commercial hay and fodder production, as a back-up food source for livestock.

9. Government subsidies, with initial financial support from the international community, to provide assistance in districts in which a drought has been declared.
10. The development of a better road infrastructure.
11. The development of livestock marketing mechanisms, with appropriate legislation, that allow a reduction in herd size during drought, and the adaptation of stocking rates to changes in dynamic carrying capacity.
12. The development of appropriate mechanisms and legislation to provide food grains from the strategic reserves to districts and divisions in which a state of drought has been declared, in order to prevent famine and starvation, but also to prevent damage to local production and trade.
13. The development of educational and extension programmes to educate the public, farmers and pastoralists and to provide them with rational options for drought management. The formation of an independent monitoring committee that can evaluate performance of the functioning of drought contingency planning in order to recommend improvements and changes.

Drought monitoring is very important, and the usefulness of the NOAA AVHRR satellite on an international, national and district scale has been demonstrated in this investigation. Besides satellite images, real-time drought monitoring should also involve the National Meteorological Department of Kenya, as rainfall monitoring is obviously another crucial element, together with the monitoring of surface and groundwater (Sharma, 1994). However, monitoring of drought *without* a comprehensive contingency plan is like measuring the fever of a malaria patient with a thermometer, but without any medicine or treatment to combat the disease.

Drought contingency planning should integrate preparedness, mitigation and response planning at various levels of severity, from a mild crisis to a disaster (Bruins, 2000b, 2000c). Rainwater harvesting is an example of preparedness and mitigation planning, as the presence of such systems can make a local pastoral household or area better prepared to mitigate drought by managing the reduced input of rainwater more intensively. If the rains fail below a certain threshold, such systems may become unreliable. Integration with groundwater resources is therefore recommended, but in a sustainable manner. The distribution of small water pumps, affordable for small farmers, would enable them to use groundwater and provide a back-up to irrigation water.

Strategic food reserves at national and district levels are the ultimate bottom line in drought contingency planning in Kenya. Such strategic

reserves should form the cornerstone of drought contingency planning, in view of reduced food production as a result of declining groundwater levels world-wide. Their formation and management, without interfering with local production and trade, seems possible but might need additional research.

IV.2 Specific recommendations for the Turkana District

The following recommendations apply to Turkana District:

1. Effective implementation of a drought and famine relief policy requires an adequate food supply through a sound national food policy. In 1981, Kenya put in place a national food policy aimed at enhancing local food production and avoiding massive food imports for food distribution to food-deficit regions. These twin objectives of the national food policy have not been realised, as a result of climatic and political factors. Politically, Kenya received a set-back when the EEC and World Bank/IMF withheld development assistance after 1990, in order to put pressure on the government to institute more political and legal freedoms and to introduce wider democracy through multi-party politics. National food security has so far not been realised. Without food self-sufficiency at the national level, the country will have to rely on external donors during droughts and famine, as has been the case in Turkana District to date.
2. At the local level, in Turkana or any other district, efforts will have to be made to avoid development efforts driven by drought and famine. Such "disaster development" usually ends up as being non-sustainable because the circumstances of its initiation are far from normal and negatively affect the perception of those for whom development is intended. Though change in Turkana is inevitable, it needs to be managed by the Turkana themselves, assisted by human and material resources from elsewhere. Such an objective has not even been enhanced by the Government Policy of District Focus for Rural Development, which was first implemented in 1983. Its aim is to alleviate poverty through participation of the local people in planning through development committees, from local, divisional to district levels. This policy targeted the ASAL districts more specifically, as they are the ones that used to return development funds to the treasury at the end of the financial year or project period, resulting from a low absorptive capacity and ostensibly, due to lack of viable development projects. This situation was turned around in Turkana District during the period of NORAD but, as noted above, sustainable development will have to be a local initiative.

3. Sustainable livelihoods in such a resource-poor and arid environment like Turkana District must have a multi-resource base. Agriculture, pastoralism, fishing and the new modes of livelihood such as charcoal burning and so on, cannot individually provide individual families with a sustainable livelihood today or in the near future. Participation by the individual or family in several modes of adaptation would ensure a broader base for risk minimisation, by diversifying risk management strategies. Ideas imported by the Turkana themselves will go a long way in laying the foundation on which others can assist them to build upon. Rain and river water-harvesting for horticultural production could be the place to start. This is an innovation that can be diffused through schools, churches and public political meetings.
4. When food shortages are experienced, there should be a minimum of infrastructure to make food accessible on the market. However, when famine relief distribution becomes unavoidable, care must be taken to avoid a situation in which relief unfairly competes with normal business practices, as has usually happened in Turkana District. The road infrastructure should be improved to facilitate transport and distribution of food.
5. The security issue is probably the most urgent at the moment and the district administration probably has insufficient capacity to deal with it. The central government, therefore, has a moral duty to ensure that both district and national borders are secure. The provision of security by the state would be of major advantage to the Turkana in many ways. Securing the south-western border with west Pokot District against raiding and attacks from the Pokot would enable the Turkana in the south to restock, because Lokori Division is endowed with good pasture and water resources. Securing the international borders with Uganda, Sudan and Ethiopia through peace treaties and patrols would ensure that illegal arms do not flow into Turkana District. It would also open the northern border areas to dry season grazing, which the Turkana no longer utilise due to frequent fatal raids from neighbours across the borders. During the colonial periods, there used to be a "red line" beyond which the Turkana would not go towards the border, patrolled by the military. When the British military administration ended after independence, the Turkana elders negotiated dry season grazing across the borders and the barter exchange of food for livestock. Of course, the Turkana also have an important role to play in their own security by restraining themselves from raiding their neighbours, especially in the north as these raids have resulted in reprisals and livestock diseases.

6. The problem of lack of markets for their livestock and the widespread incidence of livestock diseases cannot be solved at district level. It is a national problem. The Turkana District DCPU has recommended for some time that the problem of security along the borders, regular vaccination of livestock, availability of livestock drugs and the establishment of an efficient and functioning livestock marketing system be addressed in order to stabilise food security in the District (TDCPU, Annual Report, 1995). At the moment, the livestock market is dominated by the Somali, who bring in food and take away goats at exploitative rates, by the refugees at Kakuma and by local butchers.

IV.3 Specific recommendations for Kajiado District

Some ideas for action and policy recommendations are presented below, but should be discussed with both planners and the Maasai community.

1. Rainwater-harvesting methods, including roof catchments of improved houses, micro catchments and small earthen dams might be a next step in the Selengei group ranch to reduce drought vulnerability by increasing water supply and upgrading the land's carrying capacity. Technical feasibility of these innovations has to be checked first in order to prevent a waste of resources. Practical handbooks should be used such as Orev (1986) and literature such as Cullis and Pacey (1992) for Turkana.
2. Trials with napier grass and other protein-rich fodder plants need to be stimulated. For example, Dr Patrick Limimo (formerly of ACTS) has found a way to multiply a protein-rich seed which should be tried, *e.g.* by ASAL. The water spoiled near boreholes could be used in this respect. Moreover, the water from the Noolturesh pipeline, which is now used to grow crops, could be used for napier grass growing.
3. In cooperation with individuals or group ranch members certain ranch upgrading measures should be implemented. In the Dalalekutuk area, local residents have agreed to get rid of unwanted shrubs with the help of the ASAL programme. Likewise in Selengei inhabitants have indicated the degradation of the pastures due to undergrazing, which enables the growth of certain tree species *(Commiphora)*. In Meto, individuals are reclaiming degraded soils caused by cattle trekking routes. Lessons in this respect can be learned from Mwangi (1993), Shani and Perkins (1991) and Stiles (1993).
4. The wildebeest trekking in Selengei also causes erosion in the dry season grazing area. This area has recently been set aside as a sanctuary to be visited by tourists. The area (7% of the total group

ranch) has been leased to a British tour operator. The water resources needed for the planned 60-bed lodge, the grazing restriction implemented and the cutting of car tracks might mean a further degradation of the Selengei area, which needs to be carefully monitored. The contract signed between the group ranch and the operator does not safeguard the group ranch in this respect. Legal action is needed to look into this contract.

5. The Government should ensure that qualified and drought-resistant seeds are available. Agricultural work is carried out by the Maasai in a haphazard fashion, resulting to some degree in the purchase of non-suited varieties (*e.g.* from Zambia). There is a need for extension activities by agricultural experts. Those who made such errors could also play a role in warning society.
6. The Disaster Management System at the Office of the President, detailing contingency plans, monitoring, a disaster contingency fund and an emergency cereal reserve, needs to be expanded to reach all ASAL districts. Each needs to equip itself with local reserves for handling the first critical phase of drought or floods. The programme includes developing strategic urban centres as mitigation centres and maintaining key roads to enable efficient response. A good coordination at district level of food aid is recommended. Food aid should be given only temporarily and restricted to the most needy. Experiences in Turkana District show that early warning does not make sense, if it is not followed by action. This has to come not so much from the livestock keepers but from the government and the donor community. The donor community, in particular, should be warned as soon as possible. Representatives should therefore sit on the district disaster committees.
7. The government should rank ASAL development among the core areas of investment within the Public Investment Programme and allocate reasonable and adequate funds to improve infrastructure, social services and economic activities. Priority should be given to investments in infrastructure that will directly enhance the growth of the informal sector (small-scale enterprises); alternative energy development (wind/solar); water provision; and innovative development of social services for education and health, such as the deployment of mobile education units and preventive health programmes. Productivity in the ASALs could be increased by introducing and/or improving other sources of income, such as bee-keeping and the improvement of access roads.

8. A new ASAL secretariat should replace the current regional development authorities and be headed by a prominent rural planner of high repute. The secretariat should have executive capacity to enforce actions agreed by all actors. The responsibilities of this secretariat should be to oversee the development of the ASAL region in a sustainable manner that is less costly, environmentally friendly and socially acceptable. The procurement of land by influential people should cease.

IV.4 Specific recommendations for the Negev

The recommendations for the Negev are as follows:

1. In the context of drought contingency planning on a national scale, it is important to stimulate the use of local groundwater in the Central Negev, in conjunction with desalination. The extraction of good-quality groundwater in the Beer-Sheva basin causes brackish groundwater from the more elevated Central Negev to flow northward. This process may threaten the water quality in the Beersheva basin. Developing the groundwater potential in the Central Negev could (i) limit this northward flow; (ii) enhance local development of the Central Negev; and (iii) provide an alternative local water source, besides the costly imported water from the National Water Carrier System, which is relevant in terms of drought contingency planning.
2. Drought contingency planning for pastoralists should be developed, incorporating a State authority to monitor natural pasture condition, dynamic carrying capacity and fodder prices.
3. The authorities could set up a regulated framework to provide assistance to livestock growers in the country during a drought year under specified conditions.
4. The authorities should provide incentives and extension services to promote and develop commercial pastoralism in the Negev for the production of high-quality goat cheese for export and local consumption.
5. Promotion of sheep and goat meat as an alternative to beef, in view of disease problems of the livestock sector in various parts of the world. The herds in the Negev are by law immunised against foot-and-mouth disease.
6. In terms of the International Convention to Combat Desertification, to which Israel is signatory, activities should be planned to restore the historical rainwater-harvesting landscape in the Central Negev Highlands in selected parts. Large-scale reconstruction by the

authorities of ancient rainwater-harvesting systems in *wadis* would check and reverse local soil erosion and desertification, while providing more pasture.

7. This development of the Negev may offer employment opportunities to poorly educated people who live in the region.
8. In terms of tourism attractions, "living museums" of traditional livestock raising in the desert could be created, including the use of rainwater harvesting, for example around the ancient city of Avdat. The local Bedouin in the area could participate and benefit through increased employment in the tourism industry.

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Appendix I

Participating researchers and institutions

1. Principal researchers:

Prof. Joshua J. Akong'a (scientific coordinator for Kenya)
Moi University
School of Social, Cultural and Development Studies
P.O. Box 3900
Eldoret
Kenya
Phone: 254-321-43620, ext. 206; 254-0721-382155
Fax: 254-321-43407
E-mail: deanscds@mu.ac.ke

Dr. Hendrik J. Bruins (project initiator and coordinator)
E-mail: hjbruins@bgumail.bgu.ac.il
Prof. Gideon M. Kressel
E-mail: kressel@bgumail.bgu.ac.il

Ben-Gurion University of the Negev
Jacob Blaustein Institute for Desert Research
Social Studies Unit
Department Man in the Desert
Sede Boker Campus
84990 Israel
Phone: 972-8-659-6863
Fax: 972-8-659-6881

Dr. Marcel M.E.M. Rutten
African Studies Centre
P.O. Box 9555
2300 RB Leiden
The Netherlands
Phone: 31-71-5273372
Fax: 31-71-5273344
E-mail: rutten@fsw.leidenuniv.nl

2. Junior researchers:

Dr. Joram N. Kareithi (Moi University)
Mr. Francis M. Ndaraiya († 1998) (Kenya Agricultural Research Institute – KARI)
Mr. Emmanuel S. Imbogo (Turkana Rehabilitation Project (TRP) (until 1994)
Jonathan Rae (Ben-Gurion University) (1994)
Hagit Yahel (Schwartz) (Ben-Gurion University) (1995-1998)
Gabriel Berman (Ben-Gurion University) (1996-1998)
Salach Al-Assad (Ben-Gurion University) (1999-2000)

3. Others:

Mr. Rinus van Klinken
Mr. Lex Merlijn
Ministry of Land Reclamation
Regional and Water Development
Arid and Semi Arid Lands Development Programme (ASAL)
P.O. Box 213
Kajiado
Kenya

Appendix II

Follow-up of the project: capacity building and project-related publications

The project contributed to institutional strengthening of the three Kenyan institutions which directly cooperated in this project, namely Moi University in Eldoret, the Kenyan Soil Survey of the Kenya Agricultural Research Institute in Nairobi and ASAL Kajiado (the Ministry of Reclamation and Development of Arid, Semi-Arid Areas and Wastelands).

Mr. Yoram N. Kareithi of Moi University successfully defended his PhD thesis based on research carried out in Turkana District in the framework of this project. Since Dr. Kareithi is now employed as senior lecturer at the Department of Anthropology of this university, there is a continued contribution to training and education within this department.

Publications:

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AGIDS (Amsterdam Research Institute for
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University of Amsterdam
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Prof. L.W. Nauta
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