Vegetation and Climate Maps of South-Western Kenya

C G Trapnell and M A Brunt

VEGETATION AND CLIMATE MAPS OF SOUTH WESTERN KENYA

C G TRAPNELL

(lately Ecologist, East African
Agricultural and Forestry Research
Organisation (EAAFRO), Kenya)
and

M A BRUNT

Land Resources Development Centre

Land Resources Development Centre
Tolworth Tower, Surbiton, Surrey KT6 7DY
1987

CONTENTS

INTRODUCTION

This note accompanies two sets of maps of the South-western Kenya highlands at 1/250 000 scale, showing vegetation and climate-vegetation respectively. These maps, originally commissioned by the Kenya Government to provide an aid for strategic agricultural planning, have been produced by the Land Resources Development Centre (previously the Land Resources Division) of the British Government's Overseas Development Administration and the Overseas Surveys Directorate of the Ordnance Survey (previously the Directorate of Overseas Surveys). The first of these maps was published in 1966 and the last in 1986.

The background to the undertaking is outlined below.

BACKGROUND

The climate of the south-western Kenya highlands is extremely variable, resulting in a quite exceptional range of vegetation types, and an equally marked diversity in agricultural potential. This was recognised by the early workers (e.g. Edwards, 1940), and led the Department of Agriculture in the 1950's, upon a basis produced by L H Brown, to adopt a number of broad ecological zones as a practical guide to land potential for agricultural planning purposes. As part of the process of agricultural planning at District level, District Agricultural Officers were required to produce gazeteers for their Districts, in which development plans and extension programmes were to be based on these zones. This was of some importance as at this time very considerable investment in agricultural development was being made under the Swynnerton Plan, including a considerable extension of cash crop production (tea, coffee, pyrethrum etc.), the areas to be planted being largely based on the zonal mapping in the District Gazetteers.

The use of ecological zones for agricultural development planning rested on the concept that climax vegetation communities develop in response to local limitations of climate and soil. In the absence of detailed soil survey and a complete network of climatic stations, mapping climax vegetation is therefore an indirect means of establishing the limits of different eco-climatic zones, each suitable for a specific range of crops.

It became apparent, however, that the pattern of variation was in many cases less simple than appeared and, in some regions, could not well be accommodated in the L H Brown scheme. In consequence the Department of Agriculture asked the East African Agricultural and Forestry Research Organisation (EAAFRO) whether its ecologist - C G Trapnell - could resolve the discrepancies in the District ecological zones. To this end he carried out a series of reconnaissance traverses of the vegetation in south western Kenya in 1957, in cooperation with local officers of the Department of Agriculture. The reconnaissance showed that the range of vegetation types was considerably greater than previously recognised. In addition the pattern was complicated by large-scale invasions of species proper to other zones, as a sequel to the effects of human occupation. It was thus clear that a fresh survey ab initio would be required, if a full ecological framework for strategic agricultural planning was to be produced.

This led in 1958 to a formal request from the Kenya Ministry of Agriculture for assistance from EAAFRO and the British Government Directorate of Overseas Surveys (DOS) for a new ecological survey, with certain assistance from members of the Agricultural Department. The area to be covered was to be approximately 40 000 square miles, which would include all the areas of high potential in Kenya other than the coastal strip. The survey was directed by C G Trapnell (ecologist, EAAFRO) with the help of the following seconded staff: M A Brunt (land use officer, DOS, later LRDC), and W R Birch (pasture research officer, Kenya Department of Agriculture). Additional help for shorter periods was given by Mr D J Pratt (pasture research officer, Kenya Department of Agriculture), Mr E C Trump (ecologist, Kenya Veterinary Department) and Dr R Lawton (ecologist, LRDC).

The main field work was carried out between 1959 and 1961, combined with preliminary air photograph studies at EAAFRO. After C G Trapnell's retirement in 1962, further field work was undertaken by him in 1964 (with M A Brunt), 1972 (with R Lawton) and 1976 (with E C Trump) and again in 1980. Following field work, Trapnell undertook re-interpretation of the air-photography, and revision of the 137 1/50 000 scale field maps. The Directorate of Overseas Surveys, with the assistance of the Cartographic Section of LRDC, carried out the plotting work and reduced the field sheets to the publication scale of 1/250 000. In addition a supplementary set of 1/250 000 scale climatic maps on a topographic base was prepared at the Directorate from data specially provided by the East African Meteorological Department. The maps were printed by the Ordnance Survey and published as follows:

Sheet 1	Vegetation	1966	Sheet 2	Vegetation	1976
Sheet 3	Vegetation	1969	Sheet 2	Climate	1976
Sheet 1	Climate	1969	Sheet 4	Vegetation	1986
Sheet 3	Climate	1970	Sheet 4	Climate	1986

As each map was published, copies were distributed to Kenya Government Departments and internationally to scientific institutions. Copies of the maps, and relevant 1/50 000 field sheets, were also supplied to help with the planning of specific major developments: e.g. the Cherangani tea scheme, and the Tana river basin project. The extended period of publication was mainly due to the magnitude of the undertaking and to Trapnell's retirement in 1962. The subsequent work was carried out in England in his own time.

THE VEGETATION MAPS

A broad provisional classification of the natural vegetation - reflecting variations in climate - was established during the 1957 reconnaissance work. Thirteen major communities were then recognised:

1. Montane Moorland
2. Montane Open Grassland
3. Montane Bamboo Forest
4. Montane Sclerophyll Forest
5. Moist Montane Forests
6. Moist Intermediate Forests
7. Dry Intermediate Forests
8. Upland Evergreen Bushland
9. Intermediate Semi-Evergreen Thicket
10. Broad-leaved Savanna Woodland
11. Thorn Woodland and Savanna
12. Thorn Bushland
13. Desert Thorn Scrub

Using this provisional classification, field work was carried out during a series of Land Rover traverses along all the tracks in the less accessible areas, and in a close network over the remainder of the area. Traverses were as close as a mile apart in the most densely populated and altered areas of the former Kikuyu, Embu and Meru Reserves. Changes in vegetation were recorded by plotting the detailed traverse observations on 1/50 000 maps in the field, including the results of field glass observations on either side of the traverse route. The field observations were subsequently transferred from the field maps to air photographs, and used as the basis for a stereoscopic study of the vegetation pattern on the air photographs.

During this study the boundaries of the vegetation zones were plotted and extrapolated, before being transferred to 1/50 000 maps. The air photographs used initially were the RAF 1/30 000 scale ones taken between 1945 and 1950. These, however, were of very varying quality and were supplemented extensively by RAF 1/50 000 scale photographs taken between 1957 and 1963. Some of the 1967 RAF photography was also used, together with Hunting Surveys Ltd 1969 air photography of vegetation sheets 2 and 4, and, in certain cases, Canadian Air Survey air photography of the forest reserves. Thus although as many as three sets of air photography have been used in interpretation over large areas of the maps, it has been attempted as far as possible to plot vegetation boundaries as they were in the period around 1960. The maps therefore contain an important record of the surviving climax vegetation about 1960.

Vegetation of course is constantly changing under the several influences of fire, grazing, cultivation and timber extraction. This applies particularly to the climax forest areas where extensive destruction has been and still is taking place. This fact, however, in no way invalidates the concept of using vegetation as an index of land potential, provided the derived or 'secondary' types of vegetation can be satisfactorily classified in terms of their original climax vegetation. This requires some fuller explanation. In most parts of this region there remain fragmentary relics of former forest or thicket cover, which contain either some of the original climax components or subsidiary species which are observable in field work as associated with them. These may be either understorey associates of the climax or 'pioneer' species which spring up spontaneously where the climax has been destroyed. These components commonly persist sufficiently to be recognisable even where an alien bush or tree cover has invaded and overrun their original territory. Notable invaders is this part of Kenya are the Lileshwa bush, Tarchonanthus camphoratus, and several species of Acacia. Their recognition and understanding is essential in the classification of secondary vegetation.

The secondary communities are shown in the map keys under the head of the climax type from which field evidence has shown them to have been derived. For example Montane Sclerophyll Forest has been replaced variously by secondary mountain scrub at higher altitudes, by grassland with scattered Podocarpus and Cedar, by herbaceous Vernonia types of vegetation, by Dodonaea scrub mixtures, by various Tarchonanthus associations, by montane and upland Acacia types or by combinations of these with a scattering of evergreen elements indicating their original source. The full range of these secondary types of vegetation will be seen by reference to the map keys.

In certain areas where heavy cultivation has destroyed former moist forest it was not always possible to differentiate between derivation from the Moist Montane and the Moist Intermediate forests. This applies particularly in the Kisii highlands in the west, where Moist Montane Forest may have descended to a relatively low altitude, and to an intermediate belt in the east characterised by survivals of the hardwood Prunus africana (previously Pygeum africanum). In these two cases derivation is shown as from either of the climax moist forest types. Certain other minor secondary types of limited occurrence have been shown as of unspecified forest origin.

The details of this system of classification will be described more fully in a subsequent memoir to the maps. The important point here is that both climax vegetation and the related secondary communities are represented on the maps and that the land potential of the secondary types will be of the same order as that of the original climax, subject only to differences which may have resulted from land deterioration and erosion.

It follows from this that any changes which have taken place in the vegetation types represented since 1960 will simply be extensions of the processes of change which were already in progress at that time and had resulted in the formation of the various areas of secondary vegetation. For example, further areas of Montane Sclerophyll Forest will have been disturbed since 1960, to have been replaced by one of the above secondary communities. The maps, in other words, although a cross-section of the 1960 situation, provide a detailed indication of the types of change which will continue to take place in future years. Their relevance to climatic interpretation, which is essentially related to the nature of the original climax vegetation, will remain unchanged.

It should be added here that the Latin names of trees and shrubs cited in the map keys follow Dale and Greenway (1961), to whose book reference should be made for their African equivalents.

THE CLIMATE AND VEGETATION MAPS

In order to characterise the vegetation types climatically, the climax and derived secondary types have been grouped together to form ecological zones, whose boundaries, derived from the vegetation maps, are shown on corresponding topographic maps in red outline. It has been indicated in a previous publication (Trapnell and Griffiths, 1960) that these zones fall into differing climatic series. There is a general tendency for rainfall to increase with altitude, and vegetation changes proceed correspondingly in series from lower, hotter and drier conditions, to higher, cooler and wetter conditions - except at the highest altitudes where precipitation again diminishes. It was found in the field study, however, that these sequences varied greatly in character in different parts of the region. There is not, in fact, in this part of Kenya a single climatic series of vegetation types in a uniform zonal arrangement. There are three distinct major sequences involving different series of vegetation types found between the highest mountain zones and the hottest lowlands. The three major sequences are associated with three corresponding topographic regions, the Western Decline, falling towards Lake Victoria, the Rift Highlands region and the Eastern Decline falling towards the

Indian Ocean. The climates of these three regions are subject to differing monsoon controls and both seasonal rainfall and the seasonal temperature curves are affected. The regional zonal groupings adopted are therefore as follows.

Mountain Zones

H Mountain moorland and heath
BF Mountain bamboo forest

Western Decline Zones	Rift Highland Zones	Eastern Decline Zones
WM Western moist forest	MS Montane sclerophyll forest	EMU Upper eastern moist forest
WD Western *Diospyros* forest	RD *Diospyros* forest area (local)	EMI Eastern moist intermediate forest
WS Western *Combretum* savanna	UB Upland evergreen bushland	EDI Eastern dry intermediate forest
WT Western semi-evergreen thicket	UA Upland *Acacia* bushland	ES Eastern *Combretum* savanna

Northern and Eastern Lowland Zone

LA Lowland *Acacia* and *Commiphora* bushland

These zonal groupings are shown on the second series of 1/250 000 scale maps of climate and vegetation, which supplement the vegetation maps. They are summarised in Text Map 1. The symbols on this text map are the same as those used on the larger maps. The latter however, also have a number, which is simply a convenient locational reference for use when studying local climatic variations.

To provide the information for these climatic maps the Meteorological Department undertook the screening of their records and the preparation of a tabulation of the altitudes, mean monthly rainfall and yearly rainfall totals for all recording stations with records of eight years or more in 1960. This undertaking involved a total of some 550 stations, which were arranged under their reference numbers for each of the 1/50 000 map sheets. The rainfall/altitude ratios, i.e. the number of inches per thousand feet of altitude, were also calculated for every station (see EA Meteorological Department, 1961). For the relevance of this ratio see Trapnell and Griffiths, 1960. Its importance lies in the fact that it has produced a striking correlation with the vegetation zones of the Rift Highland region and that it provides a means of assessing differences in rainfall-temperature combinations in areas where temperature-recording stations are few and far between.

Using the records of the Meteorological Department, histograms of seasonal rainfall patterns were also prepared for selected stations and classified according to similarities of pattern. The classification was then extended to a scatter of other stations on the map so as to provide an overall picture of the distribution of each pattern. Potential evaporation, taken from Woodhead's figures (reference, 1968) was also superimposed on the histograms of certain stations for which the source data are complete. At the same time graphs were produced from the Meteorological Department's records (ref. 1961) to show monthly mean maximum and minimum temperatures for the main stations for which records are available. The object has been the production of a climatic map which shows, against its topographic and vegetational background, the available climatic data, without the hypothetical interpolation normally used in producing maps of climatic factors. The data shown on the climatic vegetation map therefore show for each recording station the mean annual rainfall as at 1961, the type of seasonal rainfall pattern, and locally the seasonal temperature pattern, together with the rainfall-altitude ratio. Other vital data relating to atmospheric humidity, wind strength and direction, cloud cover, insolation and hours of sunshine, are available only from the very few First Order Stations - see EA Meteorological Department (1947) and Woodhead (1968); in some instances, such as the occurrence of mists and of frost at higher altitudes, there is little more than verbal information. It is hoped to produce a coordinated account of the climatic regimes of each zone, based on the available data, at a later date.

With regard to the zones shown on the accompanying small-scale map, two modifications should be noted:-

(1) In the Western Savanna zone the greater part of the northern sector has been differentiated as 'probably secondary'. This has been done because later evidence suggests that much of the Combretum vegetation of this part may have originated in the distant past from former forest cover, or, in an area between Bungoma and the Uganda border, from semi-evergreen thicket.

(2) On the line of division between Sheets 2 and 4 a revised boundary has been inserted separating the Eastern Savanna from the Lowland Acacia zone. This demarcation is necessarily arbitrary as it crosses extensive impeded drainage areas with Acacia drepanolobium, a type which recurs in both zones. It may be mentioned, also, that the small belt of former Diospyros forest, RD on Sheet 2, may formerly have extended south towards Menengai through what is now Erythrina and Acacia vegetation.

The small-scale map is intended as a guide for picking up the zones on the larger sheets. The application of these to crop potentialities will be obvious - areas suited to specific crops can readily be determined. In recent years, however, with the pressures of an ever-growing population, the emphasis has moved away from cash crop development towards the necessities of extended subsistence settlement and of land conservation. The vegetation maps will provide a measure of the rate and extent of destruction of forests and natural vegetation cover since 1960. At the same time they should contribute to the understanding of the processes of change, which is essential for conservation management. The parallel climatic maps offer a unique basis for the further analysis and understanding of the climate in south western Kenya. As noted above, further work on this is projected and will be reported elsewhere. The results should provide valuable base-line information for work at other institutions, including the projected African Centre for Meteorological Applications for Development (ACMAD).

REFERENCES

BRITISH EAST AFRICAN METEOROLOGICAL SERVICE (1947) Mean and extreme values of certain meteorological elements of selected stations in East Africa. Meteorological Service Press, Nairobi.

DALE I R & GREENWAY P J (1961) Kenya trees and shrubs. Buchanan's Kenya Estates Ltd., Nairobi.

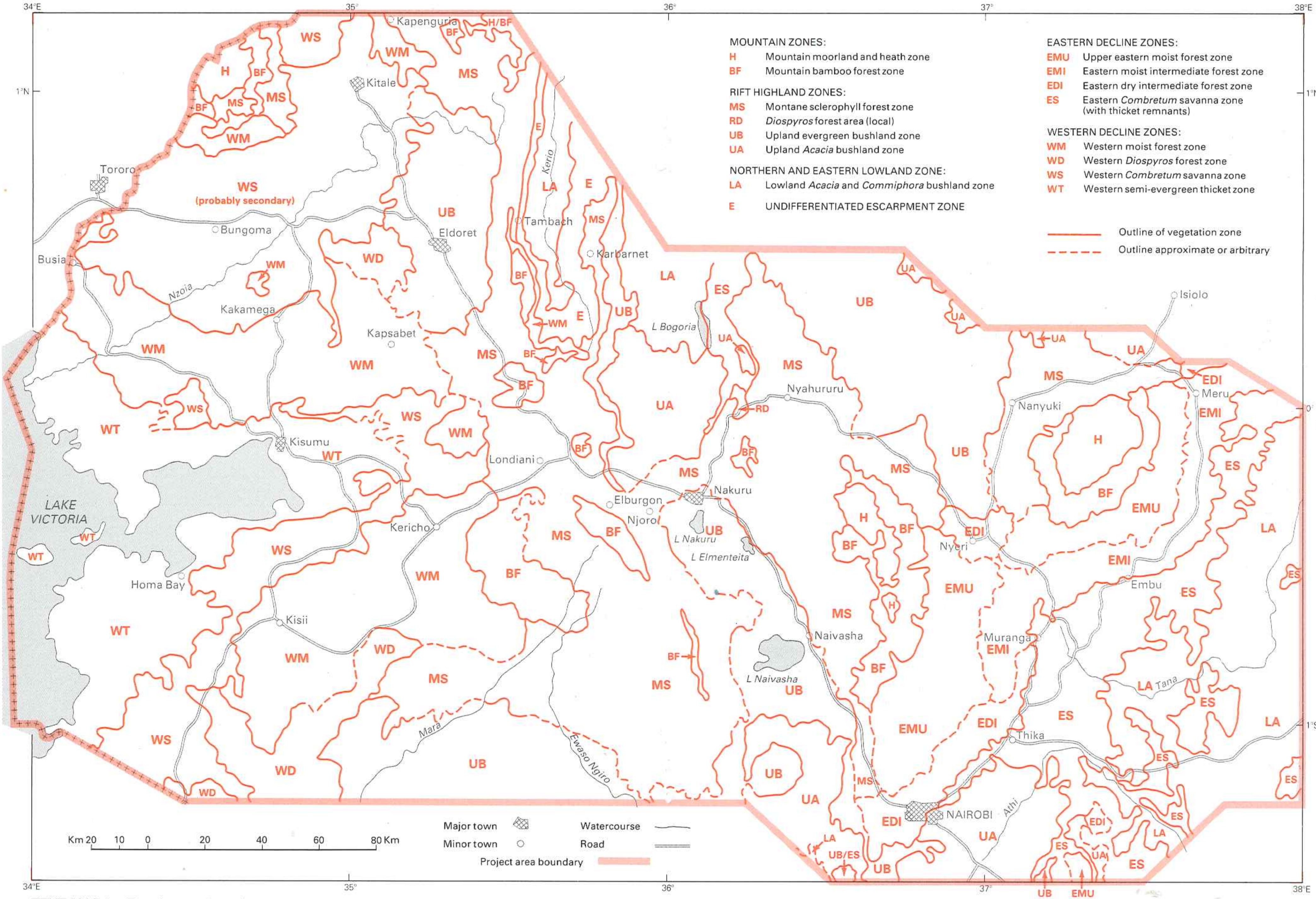
EAST AFRICAN METEOROLOGICAL DEPARTMENT (1959) Temperature data for stations in East Africa. Part I: Kenya. Meteorological Department, East AfricanHigh Commission, Nairobi.

EAST AFRICAN METEOROLOGICAL DEPARTMENT (1961) Mean monthly and annual rainfall for stations in the western half of Kenya having eight or more years of records. Meteorological Department, East African Common Services Organisation, Nairobi.

EDWARDS D C (1940) A vegetation map of Kenya with particular reference to grassland types. Journal of Ecology. 28(2)377-385.

TRAPNELL C G & GRIFFITHS J F (1960) The rainfall-altitude relation and its ecological significance in Kenya. East African Agricultural Journal XXV (4), 207-213.

WOODHEAD T (1968) Studies of potential evaporation in Kenya. Ministry of Natural Resources, Water Development Department, Nairobi.



TEXT MAP 1 Zonal grouping of vegetation types

Prepared by Land Resources Development Centre 1986