SECTION 2

Drought Climatology and Development of the Climatic Scenarios

2.1. Introduction

Drought, however it may be measured, is a deficit in available water for the specific purposes for which it is required (Palutikof *et al.*, 1982). It can be defined from three points of view: meteorological, hydrological and agricultural. The first involves an arbitrary criterion of a shortfall in expected moisture (rainfall) resulting from a change in the region's rain-producing mechanisms, some of which may be linked to shifts in the atmospheric circulation. The second definition is concerned with low streamflows and groundwater levels and, hence, inadequate water supply for irrigation, domestic and industrial uses. Agricultural drought considers supplies of water for crops and grasslands (Hounan *et al.*, 1975).

This section explores the drought climatology of Kirinyaga, Embu and Machakos Districts, defining drought on the basis of seasonal rainfall. Succeeding sections extend the analysis by incorporating more climatic variables: Section 3 computes a moisture availability index using rainfall and potential evaporation; the crop production model (Section 4) requires data on potential evaporation, radiation, humidity, temperature, wind, runoff, soil moisture-holding capacity and plant characteristics; and Section 5 utilizes the number of rainy periods, rather than total rainfall, in describing the drier zones of the study area. The within-season distribution of rainfall is included in both Sections 4 and 5.

Subsection 2.2 relates the climate of Kirinyaga, Embu and Machakos to the regional circulation patterns. Subsequent attention is given to a number of crucial questions:

(1) What is the incidence of drought in the study area?
(2) Is average rainfall increasing or decreasing in the three districts (within the time scale of the next decade)?

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(3) Is rainfall variability changing, resulting in greater or smaller probabilities of meteorological drought?
(4) Is drought in one area connected to drought in another area? Are drought episodes national, regional or local?
(5) What are the prospects for drought prediction and drought monitoring?

The climatic scenarios to be used later in the case study are defined, and historic examples from the 1970s and 1984 are given in Subsection 2.4. Finally, conclusions regarding the climate of the study area are presented.

Decadal (10-day period), monthly and annual rainfall data were obtained from the Kenya Meteorological Department. There are about 200 rainfall stations in the three districts, of which 37 have more than 30 years of records, and 14 more than 50 years. In a few places records extend back to the late 1890s for rainfall. Stations with long records may give a biased impression of the climate of the area, as they are located in relatively favorable areas where settlements have persisted. The network of full meteorological stations (5 in the study area) has only been developed in the last 20 years. Data on evaporation, wind, temperature, humidity and radiation have thus been collected at relatively few stations and for only the last 10 to 15 years.

2.2. Regional Circulation Patterns and the Climate of Kirinyaga, Embu and Machakos

The dominant controls on the weather and climate of East Africa (Griffiths, 1972) are: (a) regional circulation patterns and the intertropical convergence zone (ITCZ; *see Figure 2.1*); (b) latitude, which affects the timing of rainfall minima and maxima; (c) topography and aspect, which influence the intensity of the ITCZ and the amount of rainfall; and (d) inland lakes, e.g., Lake Victoria, which provide local sources of moisture.

2.2.1. Regional circulation and ITCZ

The ITCZ is the area of convergence between the northeast and southeast trade winds. It is not a sharply defined discontinuity of air masses and is usually identified by the coincident cloud cover and thunderstorms with heavy rainfall. The ITCZ lies about 5°S in the northern winter and about 15°N in the southern winter. The annual mean position is 5°N. The ITCZ is responsible for much of the annual rainfall of East Africa. The progression of the intertropical convergence zone, due to differential heating coupled with unequal distribution of land and water between the two hemispheres, causes a monsoonal type of flow. The northeast monsoon blows from December to February, with a maximum development in January; and the southeast monsoon blows from May to September, with a maximum in July. There is a general association of the ITCZ with rain, and of the strong monsoonal winds with dry conditions.