PERSPECTIVE

Contents

PART I PERSPECTIVE

1 SALIENT FEATURES

GEOGRAPHIC SETTING

Gorongosa National Park is situated in the geographic centre of Mocambique, astride the southern end of the Great Rift Valley system of Africa which extends through East Africa from Ethiopia to Mocambique. The Gorongosa ecosystem is contained within the co-ordinates 18° 10'S to 19° 20's and 34° E to 35° E, on the eastern, Indian Ocean, coast of Africa between the Zambeze and Pungue Rivers (Fig 1.1).

Lake Niassa (Malawi) and the Chire River which drains it south to the Zambeze, lie in the Niassa Trough sector of the Rift. The Rift Valley crosses the present course of the Zambeze at the Chire junction and extends south in a rectilinear curve to inland of the port-town of Beira where it branches and runs out in a SW direction to form the Buzi Trough, and SE to disappear in the sea between Beira and the old Arab port of Sofala. The southern-most, Mocambican, sector of the Rift, known as the Urema Trough, is enclosed on either side by higher plateau country, that on the western margin surmounted by the isolated block of Gorongosa Mountain. The mountain is 160 km inland from the sea, and the centre of the Rift Valley within the same transect is 120 km. The nearest large highland massifs to Gorongosa are the Mocambique-Rhodesian Escarpment 100 km inland to the west, and the isolated Morrumbala Mountain 150 km to the northeast near the confluence of the Chire with the Zambeze River (Fig 1.2).

A remnant of the former oldland coast plain was left as an isolated upland block by the downthrow of land in the trough faulting of the Rift Valley, and this remnant forms the eastern side of the Urema Trough, known as the Cheringoma Plateau.

FORM, CLIMATE, COVER

The build of the Gorongosa region is dominated by the Rift Valley trough, whose alluvial floor averages 40 km in width and lies between 15 and 80 m above sea level. The centripetal drainage of the Rift floor is collected by the Urema Lake which forms the lowest part and as the basin is partially endoreic it is the effective local base level. When filled, the basin discharges to the Pungue River which forms the southern boundary of the park. The upper edges of the trough rise obliquely to form the Cheringoma Plateau (300 m) on its eastern side, and the deeply incised Bárué Midlands (400 m) on its western side. Perched on the western Midlands within 21 km of the trough is Gorongosa Mountain which is 20 by 30 km in size and attains 1863 m at its highest point (Fig 1.3).

As Gorongosa Mountain is the only emminence in the region which stands in the path of moisture-bearing winds of which the most constant are the SE Trades, it forces their ascent, resulting in heavy orographic rains to its confines. The mountain is a pluton composed of fine-grained granite and is covered by rain forest with montane grassland and fynbos on the summit areas, which forms an effective sponge capturing and releasing water in a constant radial pattern of flow. The perennial streams born on this island of high rainfall, receiving more than 2000 mm per annum, form a key to life in the surrounding midlands and adjacent Rift Valley. Three of the four main streams which rise on the mountain traverse the Rift floor and meet at the Urema Lake.

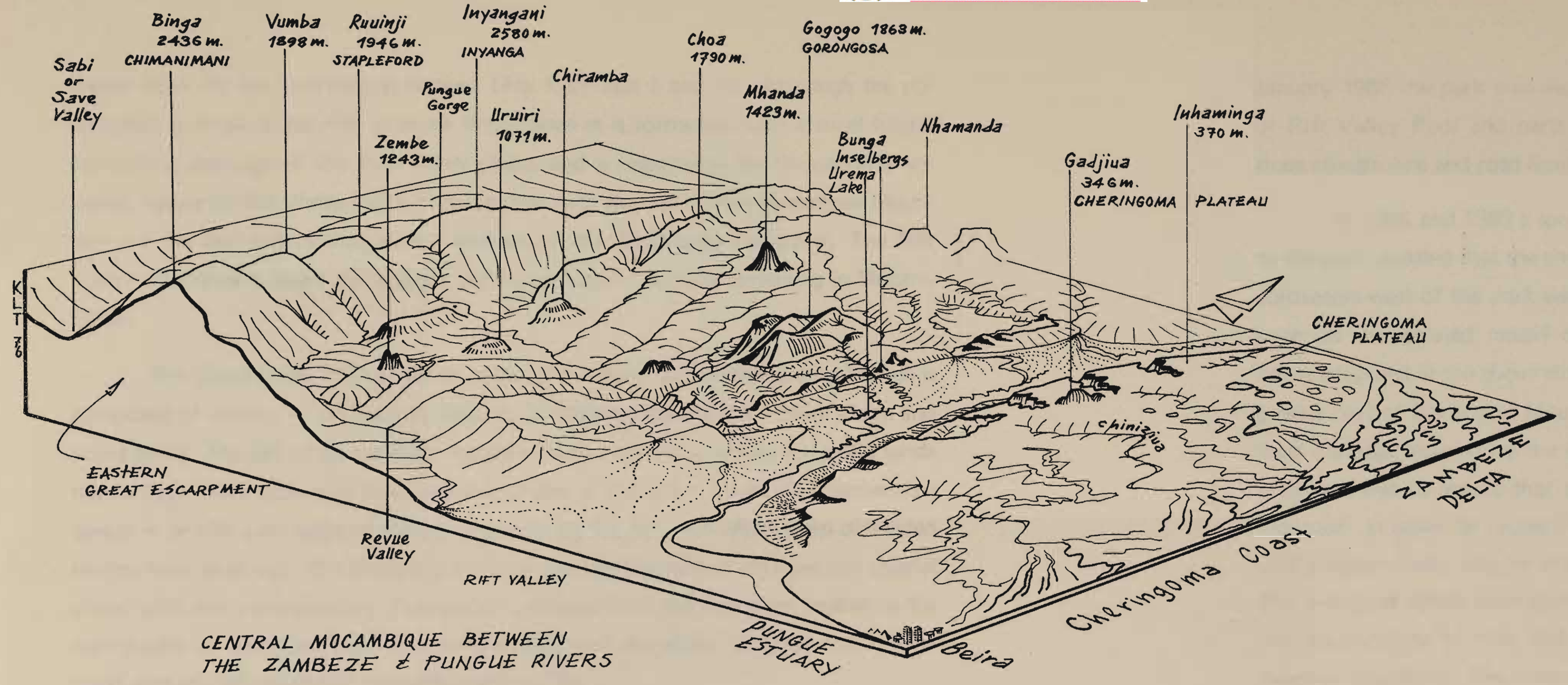
The Midland is deeply dissected spur and valley country developed on Precambrian metamorphic gneisses and migmatites. This is covered by tall ***Brachystegia*** (miombo) savanna woodland on sandy skeletal soils. Swarms of granophyre and dolerite dykes radiate north and south of the mountain, the dolerites producing fertile red oxisols which breaks the otherwise widespread monotony of poor soils in the Midlands. Rainfall is more than 1000 mm on the Midlands falling mainly in summer but with some rain in the winter; precipitation variability is only 28%.

By contrast, the Rift Valley has a rainfall of 840 mm with a markedly arid winter despite the frequency of heavy valley fogs. Rain variability is more than 60%. The Rift floor has the greatest variety of ecosystems in the region, supported by the mosaic of different types of alluvia and the seasonal flooding of the plains. Vast seasonally inundated grasslands are dotted with patches and fingers of tall acacia, mopane and combreturm savannas, dry forest on sands and myriads of seasonally rain-filled pans and termite hill thickets.

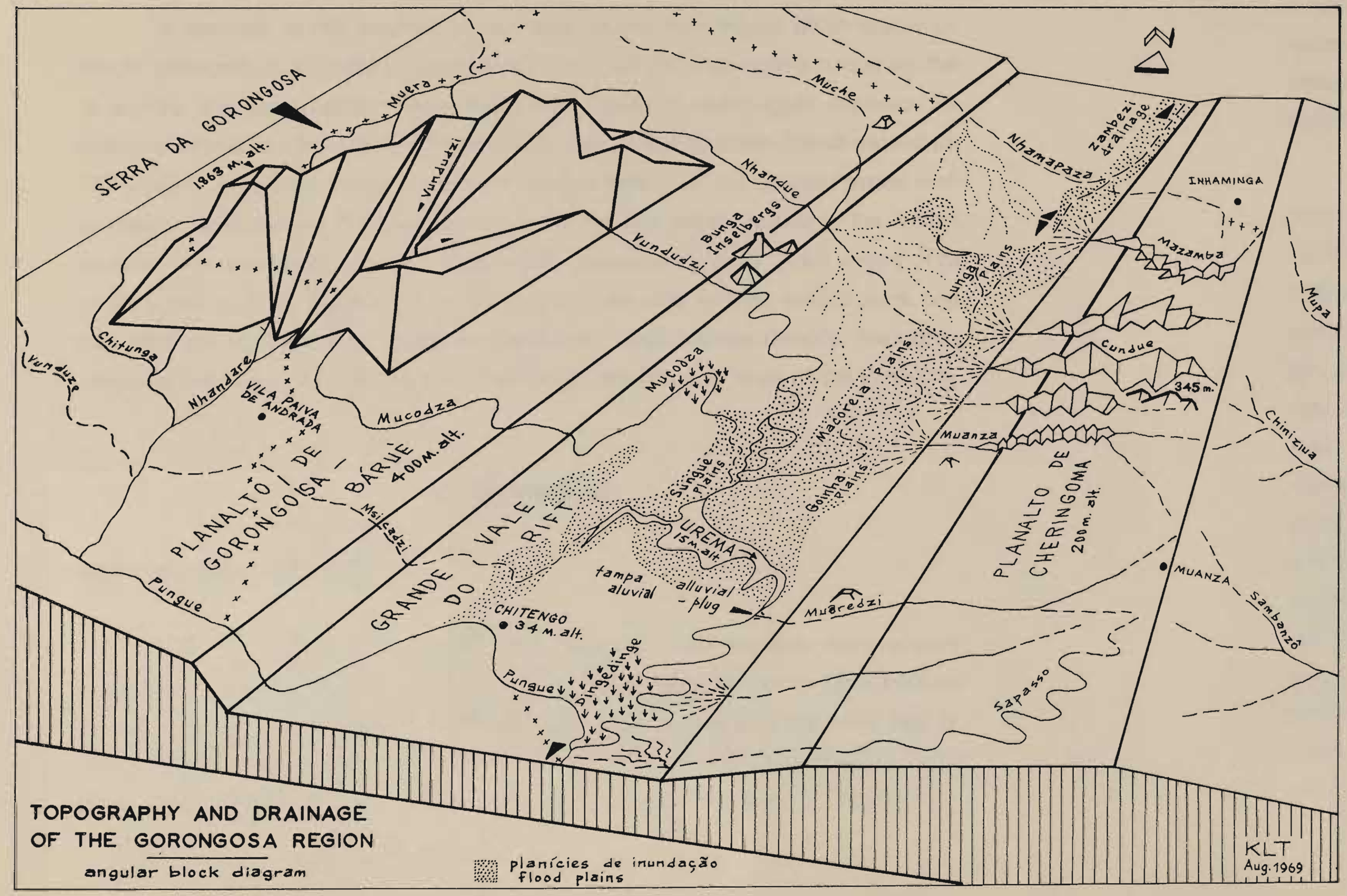
The genesis of the surface configuration of the Rift floor has been dominated by the discharge of rivers from the sides of the trough. The alluvial fans built outwards from the Rift sides by these rivers have pinched off the drainage of the trough resulting in a necklace of seasonally flooded grasslands, with savannas invading all the convex surfaces. Of these constrictions, that formed by the Muaredzi stream is unique. The greater area of floodplain grasslands (c. 600 km^2) and the Urema Lake owe their existence to this coincidence of nature — the periodic obstruction of the lake's exit by alluvium deposited by the Muaredze stream which meets the Urema drainage at right

FIG 1.3

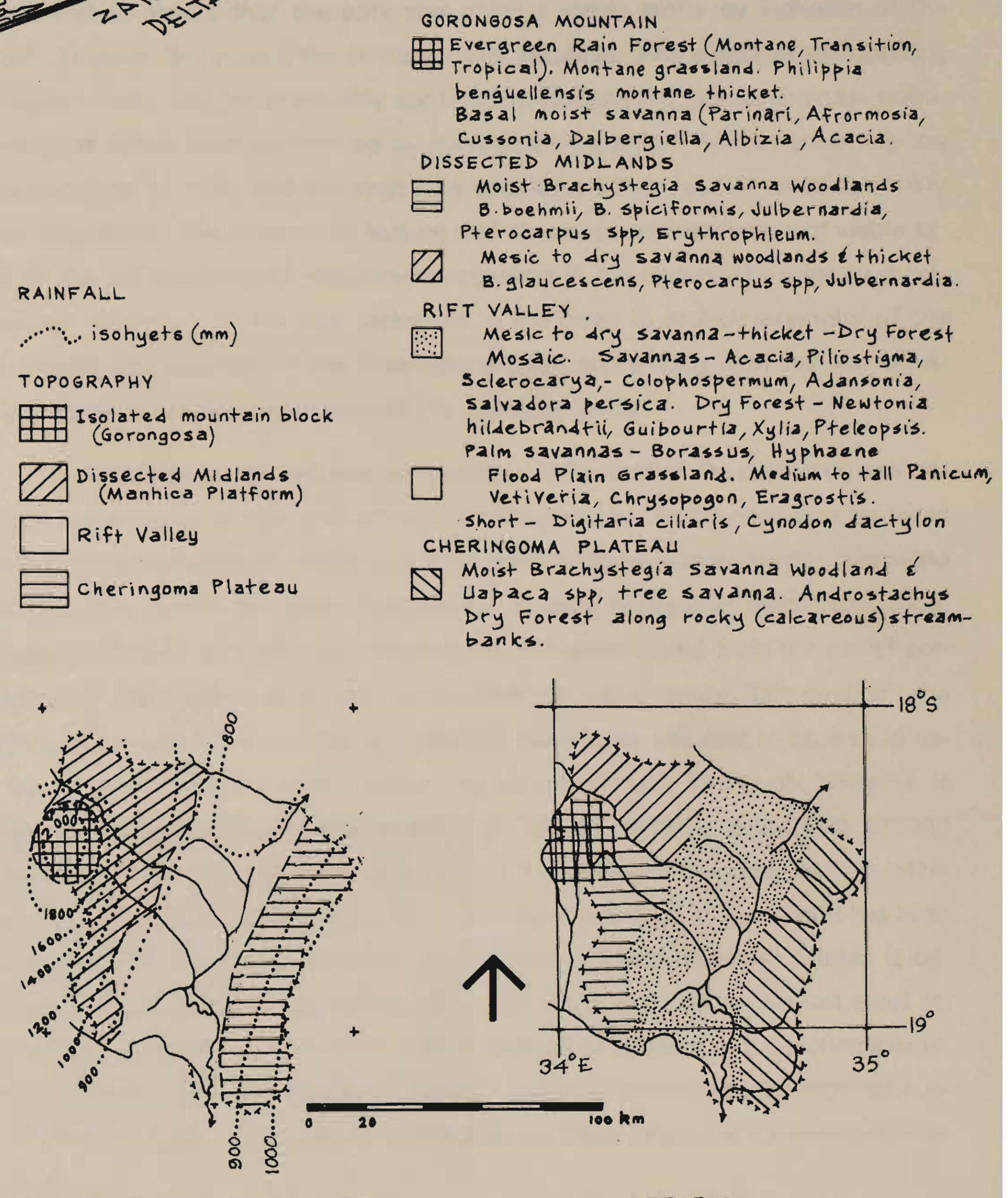
SALIENT LANDSCAPE FEATURES



CENTRAL MOCAMBIQUE BETWEEN THE ZAMBEZE & PUNGUE RIVERS



TOPOGRAPHY AND DRAINAGE OF THE GORONGOSA REGION
angular block diagram



RAINFALL & TOPOGRAPHY

VEGETATION

angles from off the Cheringoma Plateau (Fig 1.3/Plates I and II). Although the obstruction is small, it assumes extreme importance as it forms the main critical height controlling drainage of the Rift Valley plains, and is responsible for the partially endoreic nature of the Urema basin. This, together with the water from Gorongosa Mountain are the two outstanding salient features of the Gorongosa ecosystem. The Rift Valley substrates support the greatest concentrations of wildlife remaining in Mocambique.

The Cheringoma Plateau which forms the eastern side of the Urema Trough is composed of massive Cretaceous to Tertiary limestones mantled by a cover of red and pallid sands. The red sands are deep, horizonless and compact, whilst the pallid sands have a high watertable due to an impervious clay at about 1 m depth. The plateau is a cuesta in profile with stepped steeper slopes facing the Rift into which deep cliff-sided ravines have been cut. The shallowly inclined seaward slopes end in broad low coastal plains with mangrove swamps. The rainfall increases from the Rift sides parallel to the topography to just over 1000 mm on the crest and thereafter to 1400 mm on the coast, and rainfall variability decreases again to 28%.

In contrast to the miombo on the west of the Rift trough which occurs on deeply dissected hill country ("hill miombo"), that on the Cheringoma occurs on flat to slightly undulating terrain interspersed with fingers of waterlogged drainage line grassland (dambos) similar to the "dambo-miombo" of the Zambeze-Congo watershed. The plateau is covered in tall miombo forming a mosaic on the seaward slopes with evergreen forest, fynbos ***Philippia simii***, and swamp and gallery forests in the incised dambos. The seaward streams are all perennial, tea-coloured, peaty 'black waters'. The larger streams of the Riftward drainage are perennial only in their central parts, and only two, the Muaredzi and Musapasso, meet the Urema drainage directly, the others disappear into the sumps of sandy alluvial fans at the break in slope of the Rift sides.

2 DEFINITION

PARK BOUNDARY LIMITS

Gorongosa National Park was the first, and until 1971 the only, national park in Mocambique. Gorongosa was first proclaimed as a game reserve of 1000 km^2 on 2 March 1921. On 21 November 1935 the game reserve was enlarged to an area of 3200 km^2. Gorongosa received national park status on 23 July 1960 (Diploma Legislative No. 1993), and at the same time the park area was enlarged to 5300 km^2. In

January 1966 the park area was reduced to its present size of about 3770 km^2 mostly of Rift Valley floor and parts of the hill slopes forming the sides of the trough. All these straight-line and road limits excluded Gorongosa Mountain.

In 1968 and 1969 a special study undertaken to determine the ecological limits of the park revealed that the entire park system and a population of some 20 000 tribal cultivators west of the park were all dependent solely on the perennial water resource born on the isolated massif of Gorongosa Mountain (Tinley 1969). The ecological limits proposed in the above study enlarged the park to about 8200 km^2 to include the greater part of Gorongosa Mountain and the remainder of the area delimited by all the local drainage received by the Urema depression on the Rift Floor. The crux of these proposals was to ensure that the park was made a viable entity by inclusion of the mountain in order to protect the primary water resource. Any effect of surrounding land misuse would thus be effectively confined to outside the Urema drainage basin. The ecological limits were determined by analysis of the salient factors governing the life requirements of man, and the large wild ungulates which require space to satisfy seasonal migrations. The third main feature was to ensure representation of viable examples of the full spectrum of ecosystems occurring in the region. The same study recommended extension of the park eastwards to the coast to include examples of the unique forests and swamps of the Cheringoma coast and linking with the Marromeu Buffalo Reserve in the southern sector of the Zambeze Delta.

The reduction of the national park area in 1966 marked the beginning of a political and conservationist defeatest attitude mollifying invasion of park area by tribal cultivators, and pressure from timber and safari companies to exploit as-yet undamaged natural resources within the park. Contraction of park boundaries meant that tribal cultivators which had invaded from the margins or had remained from the earlier cotton plantation days would with each contraction be conveniently "left outside" the new limits. The land hunger of the surrounding cultivators was said to be a valid demand for this and other boundary reductions were envisaged. The truth, however, is that vast uninhabited areas of well-watered, high rainfall, miombo woodlands are and were available all around the park especially in the midlands between the mountain and Chimoio (Vila Pery) area to the SW – but there was lack of game as it has been exterminated. The sole reason why park area of low and unpredictable rainfall is called for by cultivators (or those behind them for ivory) is to get at the last meat resource – their hunger is for protein not land. Instead of authorities protecting this resource for rational utilization leading toward maximum benefit for the regional economy, it was politically expedient to rather give up these resources for eventual total elimination.

P

(1) mountain catchment,
(2) Urema Lake & floodplains,
(3) in the foreground the sill (alluvial plug) responsible for (2), formed by Muaredzi stream deposits from the right.

PLATE II DRY SEASON ASPECT FOUR TO FIVE MONTHS LATER OF PART OF THE SAME AREA SHOWN IN PLATE I.

Sill formed by alluvial plug clearly exposed by low-water conditions, displaying its key role in pinching off the Rift Valley drainage at this point.

PLATE III HIGH FLOODWATERS INUNDATING THE DINGEDINGE SLACKS AT THE UREMA-PUNGUE CONFLUENCE IN MIDSUMMER (Jan. 1970)

In the foreground termite hill islands in various stages of development and erosion

PLATE IV THE DINGEDINGE SLACKS IN THE DRY SEASON SEVEN MONTHS LATER

The same area shown on the right of Plate III. The different green and brown grass tones indicate different soil moisture and salinity levels.

Until the present (1976) the 1966 boundaries have been maintained though there are constant pressures for its further reduction for exploitation. Since independence the Mocambique authorities have forbidden cultivation of Gorongosa Mountain above the 600 m contour around its base.

STUDY AREA

The Gorongosa ecosystem is that area delimited by almost all the drainage caught by the Urema depression. The one exception is a seasonal 'sand river', the Nhandue, which enters the park in the NW after rising far to the west near the base of the Great Escarpment. Apart from this river which rises outside the Gorongosa area all the drainage into the Urema Lake is local from both sides of the Rift trough. This Rift floor lake is a partial internal drainage basin which, when filled, overflows into the Pungue River.

Rightly, the study area should be referred to as the Urema ecosystem, but the region as a whole and the national park are named after Gorongosa Mountain. In addition the perennial water born on the mountain is the key to human and animal life in the whole region (Tinley 1969, 1971). The mountain was named after the first chief to settle there in the history of the tribes. Further south between the Buzi and Save Rivers is a small river which rises on the Buzi Coastal Plateau referred to as Gorongose spelt with an *e* ending).

The Gorongosa ecosystem therefore comprises the entire park area plus the terrain west to include Gorongosa Mountain and its radial drainage, and eastwards to the divide on the Cheringoma Plateau separating the seaward and Riftward drainage. On the Rift floor the limit of the ecosystem in the north is the seasonal 'sand river', the Nhamapaza, close to which is the faint convex surface forming the divide between the Zambeze and Pungue drainage. In the south the perennial Pungue River is the limit as the convexities separating it from the Urema depression are formed by the alluvial deposits of this river.

From the divide along the crest of the Cheringoma Plateau, which is a cuesta in profile, the seashore is just under 100 km distant. On the white podsolized sands of the seaward dipslope is a mosaic of unique ecosystems comprising forests, fynbos, exten

sive dambos with oval pans, and large estuaries covered in some of the finest mangrove forests (containing 9 species) on the Mocambique coast. Some of the systems are not represented, or only fragmentarily so, elsewhere in Mocambique.

Presented with this unique montane to mangrove ecocline transect across a stepped landscape and climatic sequence parallel to the coast, I included the seaward sector as an extension of my study area, for comparative purposes, quite as much as for its distinctiveness.

3 APPROACH

> "The observer must empty his mind and be receptive only of the deer and the signs of the country".
>
> Frank Fraser Darling 1937

A holistic ecological approach is used in this study. Emphasis is on the salient reciprocal relations and succession of the important biotic communites or their components with landscape processes. In many regions large changes in habitat structure, relative plant and animal biomass, species composition, and complete community replacement are wrought over contemporary time (let alone in geologic time) by normal geomorphic succession without any change in the local or regional climate. This succession is either due to factors which alter the soil water balance, or to the spatial replacement of land surfaces by erosion and sedimentation. It can also be due to within-habitat changes due to selection and influence of biotic competition and the activities of animals including man.

As correlations of these relationships and processes require both a total interacting framework and the details of the main components of that framework, presentation is divided into three sections. Part I titled PERSPECTIVE provides the essence of the Gorongosa ecosystem and the approach by which the details of Part II CORRELATION are built. Part III KALEIDOSCOPE attemps to relate the salient features of processes and correlations into an evolutionary whole caught at that particular stage in space and time by the study. Such an appreciation of ecosystem dynamics at the salient factor level supported by detailed data will then allow prediction of past, present, and future changes or tendencies. These criteria are central to the realisation of significant conservation management based on causes. The effects are however important for determining many of the causes.

Ecosystems are of inordinate complexity. This feature is emphasized repeatedly in the literature, in the training process and by field experience. It is well known that disturbance to one part of an ecosystem can set up a chain reaction affecting many other components, the result of which are hard to imagine let alone predict. But each ecosystem is in fact governed by a few relatively simple ***salient factors***, a feature of ecosystems rarely mentioned anywhere. The identification and protection of the salient factors holding an ecosystem together ensures survival of its components and processes over the long-term in a human temporal scale. In the geologic time scale, however, it would merely act as a damper to the tempo of inexorable landscape change. The method I have used over the years with some success for analysis of natural ecosystems is shown in Table 1, using the terms key and master factors. The most lucid exponent of salient factors analysis is Ian McHarg (1969) whose entire approach to landscape planning is determined by the salient factors governing each ecosystem. His chapter titled "Processes as values" is a masterly treatment of the method, and in three words synthesizes a main criterion of analysis. McHarg's methodology and terminology is more elegant and refined than my own although the same results can be obtained. I have therefore used his term salient in preference to key and master factors.

Salient factors are the keystone elements holding an ecosystem together as a viable dynamic system. The loss of any one of these factors would cause perturbations (multidirectional shifts in trends) and replacement of the system or its component parts. The salient factors important at any one time are replaced by others through changes imposed by natural processes. Ecosystems are of various kinds and sizes and the salient factors controlling the viability of each will vary accordingly. In addition, not only is it usually impossible to study all the details and complexities of an ecosystem in a life time, it is also unnecessary, as once the salient factors have been determined further indepth study will not change their key importance.

In each ecosystem there is a hierarchy of salience. This depends on the dimension of the ecosystem under study and on the components identified as requireing priority attention. The salient factors form a pyramid composed of five levels of salience (Table 3.1). In each level the factors are evaluated in a gradient of values from most to least. Either the maximum condition or the minimum can be the most important for different ecosystems. For example a forest may require high soil moisture with good drainage, a swamp also requires high soil moisture but with poor drainage. What are the salient factors maintaining these two requirements and what are the implications? In certain circumstances fifth level components (Microbiotic), such as tsetse-fly or anopheles mosquito that are disease carriers, are moved up to the second level (Major Components) because of their impact.

These features require to be mapped at intervals to provide templates of the changing importance of various key and master factors to anticipate or predict what will result from their influences. In this way planning and management (protection and utilization) is causes-based on the salient processes and interactions governing a particular system or situation. The ecological study thus passes through the following cycle: (1) synopsis (salient factor analysis), (2) correlation, (3) synthesis, (4) application, (5) response monitoring, (6) re-assessment and back to (1). Most situations can however be adequately handled by going directly from (1) to (4) to (6) and back to (1) again. As most management programmes are biologically biased they typically start and stop at (2) or leap to (4) setting in train a bewildering new series of interactions superimposed over the natural ones. Management at all levels thus requires a rational, explicit and replicate method (McHarg 1969) from which to work out from and back to. Another value of the method is that it enables studies to get to the root causes rather than attempt protection and control by dealing with the effects.

As natural processes are dynamic it is necessary to identify and evaluate those operating under present circumstances. In addition, it is vital to identify the tendencies exhibited by the present processes toward future changes. Many of these tendencies are successional and are thus part of an inexorable change which can only be slowed or ameliorated. Without the last data no valid evaluation or interpretation can be made with the other information for predictive purposes and management action.

The five levels of salience show a pyramid of increasing complexity from top to bottom and increasing importance from bottom to top (Table 3.1). The gradient of importance is based on the precept that if the ecosystem as a whole is maintained, survival of its components is ensured, at least in a human time scale.

Ecosystems study requires the worker's complete immersion and empathy with the subject, to 'feel' in the Taoist philosphic sense by becoming the ecosystem oneself — I am the inselberg, the plains and the totality of the elements and life at play on them. Such a sixth sense or 'bump' of ecology is similar to that possessed by some individuals for direction. Primitive man confronted with a landscape can assess its qualities as his bump of ecology is probably honed to maximal awareness by survival of the multiplicity of experiences that he has been exposed to since birth. His search for food, particularly, educates him into ecological awareness; his stomach is therefore the master tutor.

TABLE 3.1

HIERARCHY OF SALIENCE
(or of key and master factors)

1st Level: **REGIONAL ECOSYSTEM**

eg. ocean, continent, island, desert, mountain, river basin. Natural processes of landscape evolution, climate, hydrography, geomorphic and edaphic controls. Extremes, opportunities and limitations expressed by the intrinsic features, and their controls.

2nd Level: **MAJOR ELEMENTS**

(elements with the greatest impact, most importance or largest space requirements)
Examples:

(a) Man (hunter-gatherer, fisherman, pastoralist, cultivator, bee-keeper, technological man)

(b) Large wild ungulate migrations (seasonal limits and episodic occurrence: substrate controls in each sector)

(c) Representation of the full spectrum of ecosystems

(d) Unique elements (eg. scenery, aquifers, endemics, rare or endangered species)

3rd Level: **INDIVIDUAL ECOSYSTEMS**

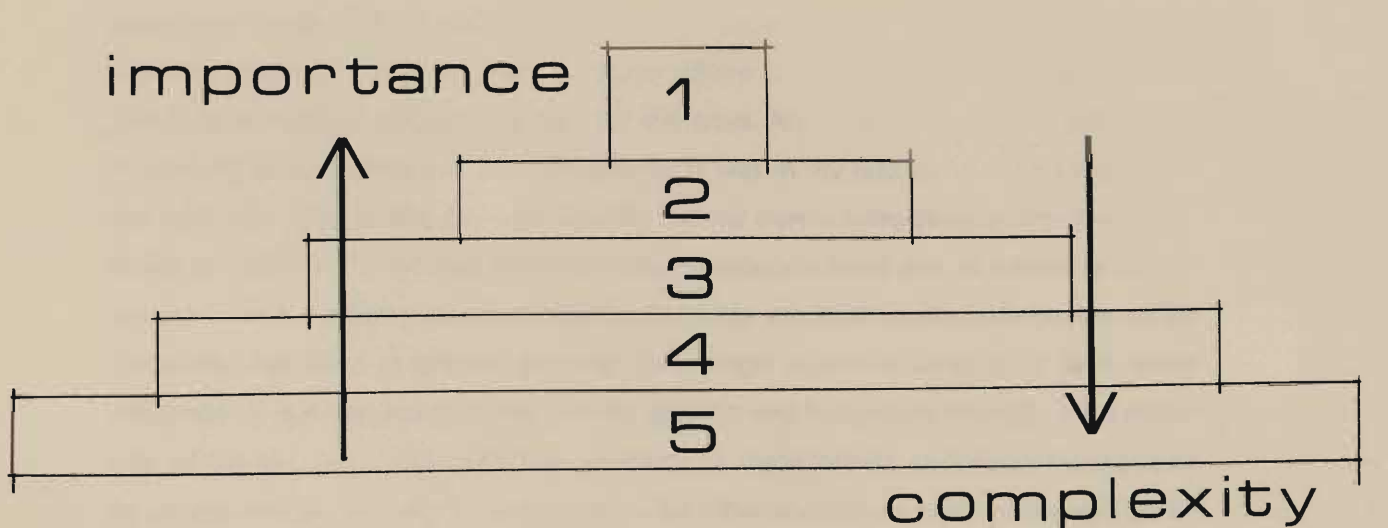
(and Communities)

4th Level: **MACROBIOTIC COMPONENTS**

(eg. ungulates)

5th Level: **MICROBIOTIC COMPONENTS**

(eg. insects)



This total identification with, and joy in, their habitat is a feature of most hunter-gatherer peoples of the world, particularly the Red Indian of North America (Grey Owl 1931; Mails 1974: 18–19), The Australian Aborigine (McCarthy 1957), the Mbuti Pygmies of the equatorial rain forest (Turnbull 1961), the Bushmen and members of pastoral and cultivating tribes that still practise hunting and gathering, and some modern naturalists. Bushman claim they have a telepathic system which enables them to feel the presence of springbok on the far side of a hill as they are so keenly aware of the wind blowing through the dark hair on the animals flanks, or the presence of strangers long before they have arrived (Bleek & Lloyd 1911, van der Post 1961, Eve Palmer 1966: 74, 138). Turnbull (1961) describes how, on returning to their forest home after an excursion to neighbouring tribal cultivators, pygmies became more and more animated and excited until they spontaneously shouted greetings to the forest, expressing the sheer joy they felt in the completeness of life.

Despite the fact that students attracted to research are probably those with more than usual curiosity, this personification of the subject in the imagination is vital to modern man in producing original research as it enables him to picture in his mind how the processes work (Beveridge 1950). It allows the subconcsious to absorb the total make up of the subject and its unique features; the conscious acquisition of the details can then be worked on in a context which allows the mind to use creative thinking to attain orginality or new ways of seeing the same subject. The tools for forward-moving creative thinking are by the use of, (1) stepping-stone (intermediate impossible), (2) random juxtaposition of ideas, and (3) reappraisal of ideas reckoned to be perfectly right and absolute (challenge for change) (De Bono 1973).

The trained ecologist entering field work for the first time has to learn how to identify completely, and attain the telepathic awareness of the hunter-gatherer, with the ecosystem. As even the unique rapport primitive people have with their environment is unable to develop intellectually as it is restricted by superstitions and beliefs, and day to day survival; likewise modern education conditions individuals and traps cultures into accepted ways of doing things, channelling ideas and disciplines to the specialised subservience of idealogical, technological and economic values (Reich 1970, Tinley 1974). Only by integrating disciplines and ideas through lateral thinking (De Bono 1973) can modern man transcend all these conditioning processes to restore material values as the tools of men, and human and evironmental values as the determinants of life.

It is thus not enough to recapture the ecstasy of wonder and curiosity at the spiritual and intellectual level and identify completely with one's environment without extricating the mind from conditioned thinking. Combining these as part of the evolution of the self realises the core of existence. What is required is the kind of empathy obtained by some unorthodox experimenters with their living plant subjects (Tompkins & Bird 1974).

The diversity of natural systems and habitats in a region means an increased array of choice (platicity) for organisms under changing environmental conditions, as many kinds of systems each have different responses and potentials to these changes. Evolutionary success can in one sense be defined as the maintenance or increase of reproductive fitness by opportunistic response to changing conditions. This response can be by migration, a change in habitat use, or by organic change.

Consider the relatively poor array (brittleness) of habitat variety expressed by a pure grassland as opposed to a compound habitat such as a savanna. These differences in variety are intrinsic expressions of brittle as against plastic ecosystems. In the same way, fullness of the human condition can be defined by the old saying "variety is the spice of life". In ecology a good grounding in earth and life sciences is vain without it maturation through a diversity of field experience. Total identification with one's subject is required on the one hand, whilst exposure to other biomes and life ways is as vital for comparison, stimulation and new approaches. A balance is required so that the worker neither becomes desensitized by staying too long in one site, growing with the changes and thus not able to 'see' them, nor merely occupying the superficial role of visiting scientist.

Those who have maintained a balance of in-depth studies correlated with salient analyses in other systems, for example, have the opportunity to cross-correlate disciplines and attain originality and meaningful expression by a freshness maintained through the stimulation of variety. This faculty is well exemplified by a Theodore Monod or Fraser Darling who in one week can lucidly assess the co-relations and their limiting factors in an ecosystem or region where local scientists have spent twenty years effort without seeing the wood for the trees. My most unforgettable experience of looking at something and not recognizing it was in my late teens when I was out in the veld with friends one day and casually turned over a loose stone at my feet. When it was pointed out to me that the object was a prehistoric hand-axe, in a blaze of enlightenment I was suddenly able to recognize stone-age implements everywhere. My earlier 'blindness' had been in spite of growing up amongst primitive tribes on a farm where sharpness of eye was honed every day by playing and hunting in the veld. Thus evolution of the self, too, comprises lifting as many of these 'blinds' as possible by exposure to variety and by striving for versatility. Like other animals we need to undergo periodic change or migration. It can thus be said that the maintenance of diversity is fundamental for the evolutionary success of both ecosystems and individuals – variety is life, as this thesis plans to show.

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