UNITED REPUBLIC OF TANZANIA

KILIMANJARO REGION
INTEGRATED DEVELOPMENT PLAN

MAIN REPORT : VOLUME TWO

October 1977

JAPAN INTERNATIONAL COOPERATION AGENCY

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Overseas Technical Cooperation:

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Printed in Japan
October, 1977

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NATURE CONSERVATION
WATER RESOURCES
AGRICULTURE
INDUSTRY
TOURISM

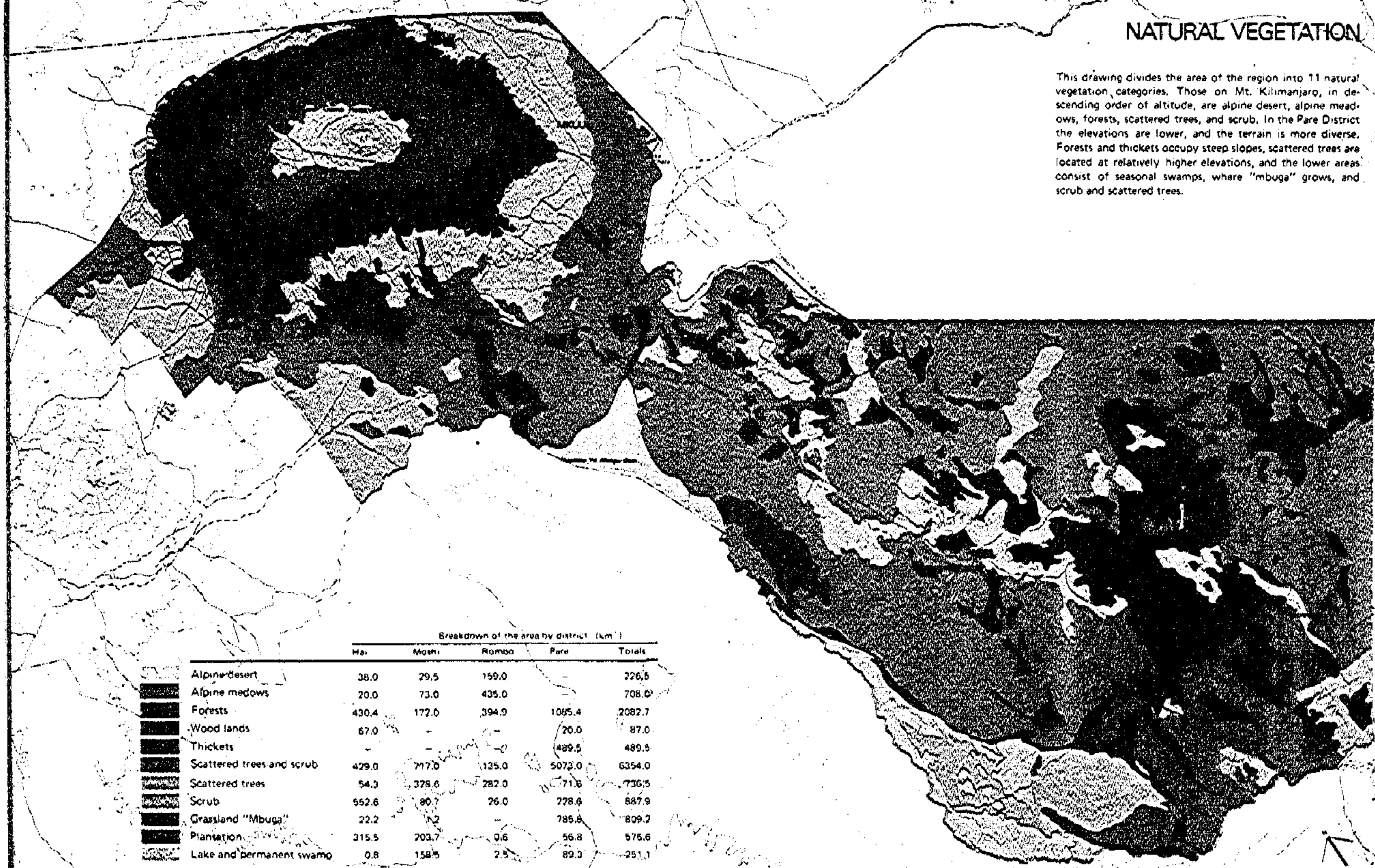
KILIMANJARO IDP

NATURE CONSERVATION

7

NATURAL VEGETATION

This drawing divides the area of the region into 11 natural vegetation categories. Those on Mt. Kilimanjaro, in descending order of altitude, are alpine desert, alpine meadows, forests, scattered trees, and scrub. In the Pare District the elevations are lower, and the terrain is more diverse. Forests and thickets occupy steep slopes, scattered trees are located at relatively higher elevations, and the lower areas consist of seasonal swamps, where "mbuga" grows, and scrub and scattered trees.

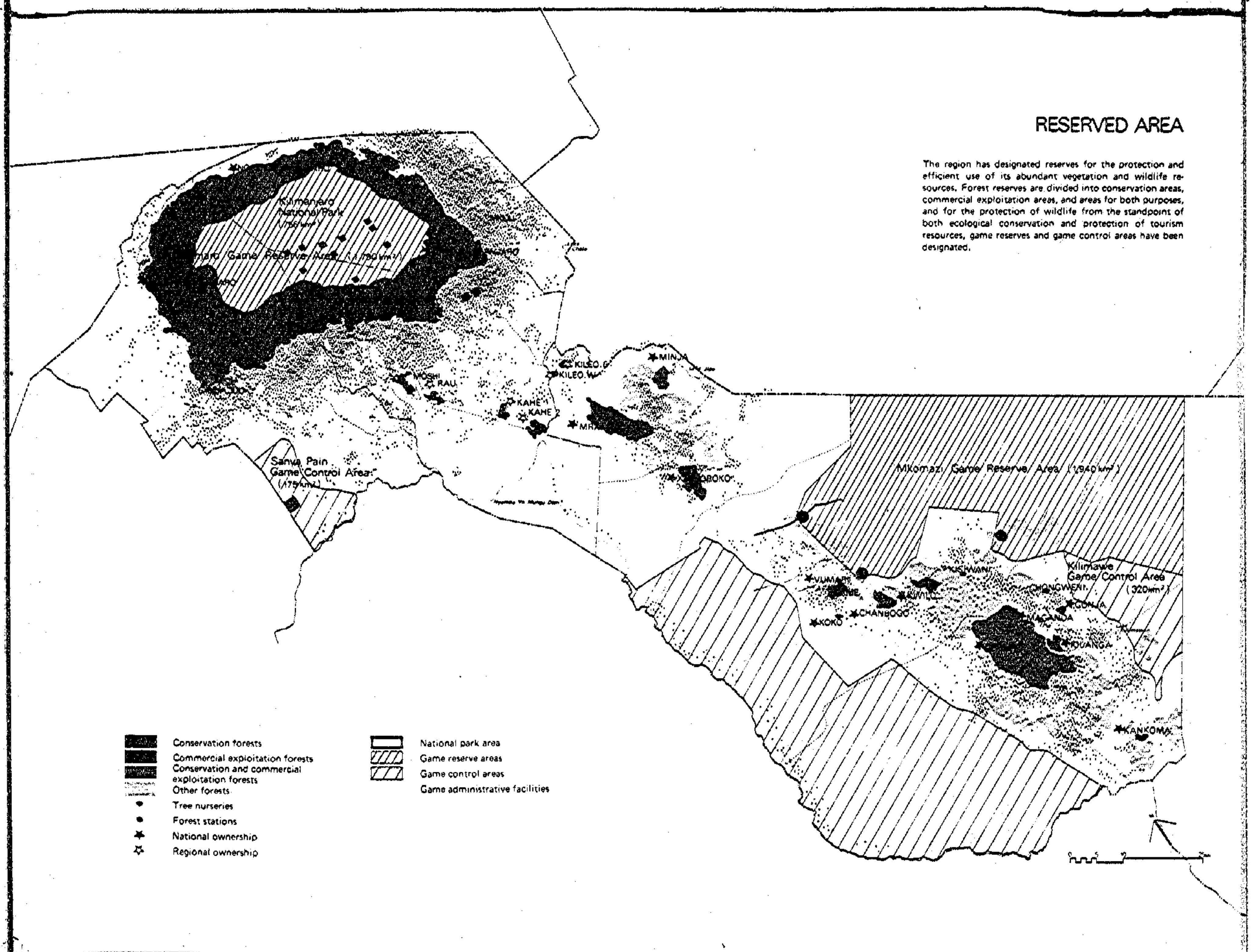


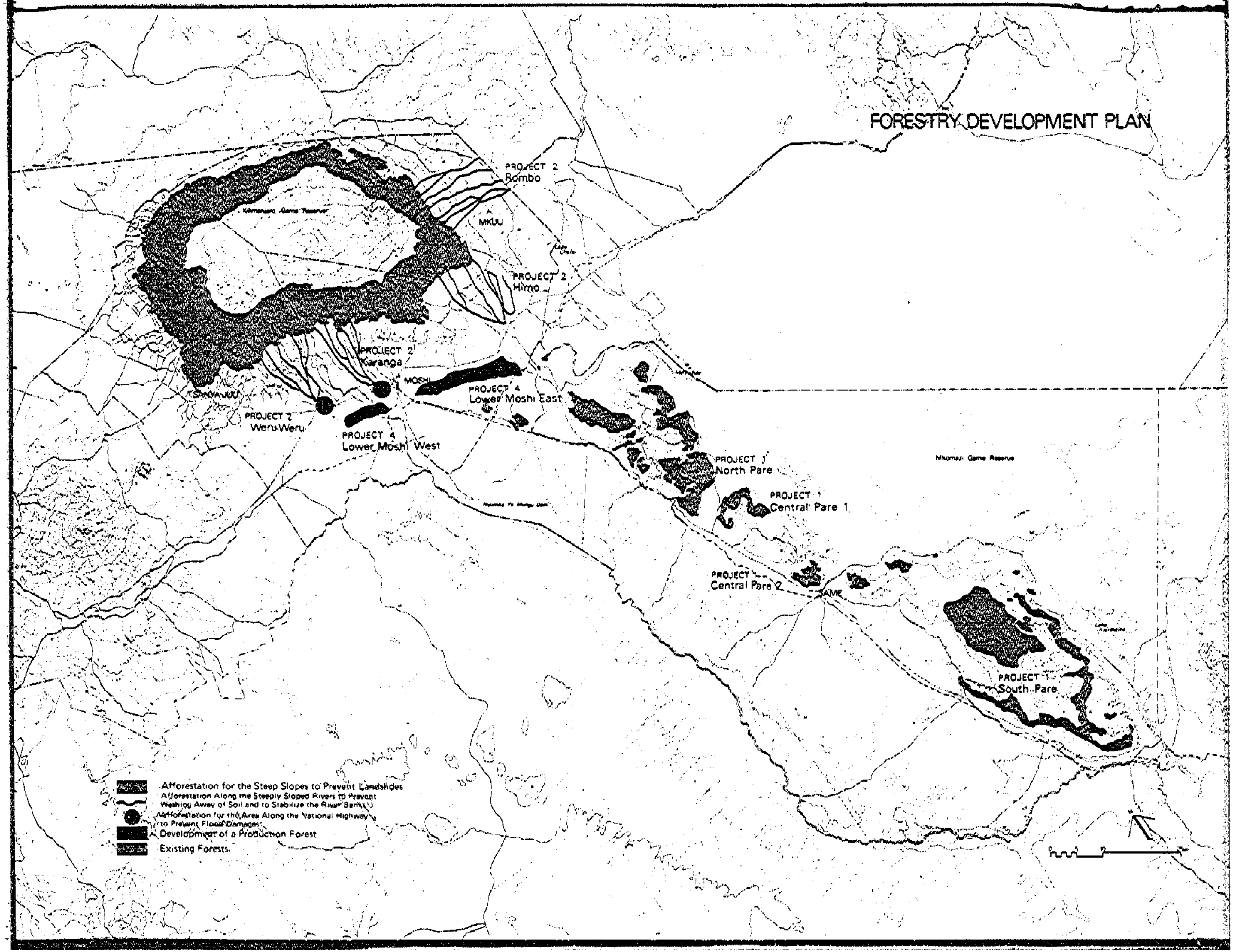
Breakdown of the area by district (km²)

	Hai	Moshi	Rombo	Pare	Totals
Alpine desert	38.0	29.5	159.0	–	226.5
Alpine medows	20.0	73.0	435.0	–	708.0
Forests	430.4	172.0	394.9	1085.4	2082.7
Wood lands	67.0	–	–	20.0	87.0
Thickets	–	–	–	489.5	489.5
Scattered trees and scrub	429.0	717.0	135.0	5073.0	6354.0
Scattered trees	54.3	328.6	282.0	71.6	736.5
Scrub	552.6	80.7	26.0	278.6	887.9
Grassland "Mbuga"	22.2	2.2	–	785.8	809.2
Plantation	315.5	203.7	0.6	56.8	576.6
Lake and permanent swamp	0.8	158.5	2.5	89.0	251.1

RESERVED AREA

The region has designated reserves for the protection and efficient use of its abundant vegetation and wildlife resources. Forest reserves are divided into conservation areas, commercial exploitation areas, and areas for both purposes, and for the protection of wildlife from the standpoint of both ecological conservation and protection of tourism resources, game reserves and game control areas have been designated.





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NATURE CONSERVATION PLAN

Contents

1. GENERAL

1.1 Purpose of the Planning

The fact that the Kilimanjaro Region is one of the most agriculturally productive regions in Tanzania is an indication of the high value of its natural environment. Furthermore, for the sake of the economic progress of not only the region itself but also the entire country, it is necessary that this valuable natural environment be maintained permanently so that it can continue to be of use value.

The region is also rich in natural environment of scenic or tourist value, including the alpine zone on Mt. Kilimanjaro and the wildlife of the Mkomazi area.

This plan is for the systematic conservation of both of these aspects of the natural environment of the region.

1.2 Scope of the Studies

The nature conservation plan consists specifically of two plans--a forest plan and a game conservation plan--which are based on an ecological analysis of the major elements of the natural environment in the region, including climate, terrain, soils, and vegetation:

(1) Forest Plan

This plan suggests measures that should be taken to conserve and nurture forests as sources of building materials and fuel and for the sake of securing water resources, preventing river bank erosion and the washing away of topsoil, protecting steep slopes, maintaining the quality and volume of river water, and so on.

(2) Game Conservation Plan

This plan suggests measures that should be taken to conserve wildlife not only for its economic value in terms of tourism and leather and other processing industries but also for its lasting cultural value to the world.

2. INVENTORY OF REGION AS A ECOLOGICAL BACKGROUND

2.1 Topography

Eastern Africa, the highest part of the continent, is known as its "roof." This high elevation is due to the major volcanic strip that has resulted from the influence of the great African Rift Valley, the largest in the world, which runs in a north-south direction along the eastern part of the African continent. Here are found Mt. Kilimanjaro (Kibo Peak, 5,895 m), the highest mountain in Africa, and Mt. Kenya (5,200 m), as well as many other high peaks.

Mt. Kilimanjaro, which was formed from volcanic activity on what was previously a plain, is a scenic symbol of Africa. It is nearly conical in shape and has a gentle slope the skirts of which reach out to a radius of approximately 40 km.

The Kilimanjaro Region is formed around this mountain and the Pare mountain system. The Mt. Kilimanjaro area can be classified into three major altitude zones:

(i) The mountain zone above 6,000 ft. (forest reserve and alpine zone)

(ii) The mountainside zone between 4,000 ft. and 6,000 ft. (highland zone)

(iii) The zone below 4,000 ft. (upper lowland and lowland zones)

Similarly, the Pare mountain area can be classified into two zones:

(iv) That above 3,000 ft. (highland areas)

(v) That below 3,000 ft. (footland zone and that part of mountain zone that does not include highland areas)

Above 6,000 ft. the southern slopes of Mt. Kilimanjaro are the steepest and, in swamp areas, have been severely eroded by rainfall over long years. As a consequence, the terrain is rather complicated. On the north side of the mountain, on the other hand, the terrain is quite simple because of a gentle gradient of 5-10 deg. and a lesser amount of rainfall. Since the shape of the mountain is conical, rainwater runs off it almost evenly in all directions.

The zone between 4,000 ft. and 6,000 ft., where the slope is 3-8 deg., is where the rainwater that falls farther up runs together after passing through the swamplands and where the fertile surface soil washed down from the forest zone accumulates. Although erosion of swamplands is less pronounced here than above 6,000 ft., it can be expected to get worse in the years ahead because of the susceptibility of the soils to erosion.

On the east and north sides of the mountain the forest belt narrows to 5.0-6.0 km.

All seasonal swamps in this zone have disappeared owing to seeping underground, evaporation, and tapping of water for household use. There are some small streams, but their combined length is only about 15-20 km. This is an indication of considerable erosion in the zone above due to rainfall and of collection of water in many small, separate areas.

The terrain is relatively flat below 4,000 ft.--0.4 deg. Here there are a few rivers, but most of them are seasonal owing to underground seepage and severe evaporation.

The rivers that run off Mt. Kilimanjaro run into the Pangani R. on the south side and the Lumi R. on the east side. On the south side there are also many seasonal swamps, which are considered to be due to the gushing upward of underground water from the zone above 6,000 ft. with increased rainfall in the rainy season. Along the Pangani R. is to be found the Nyumba ya Mungu reservoir, which was created by improving swampland for the purpose of irrigation.

The Pare mountain system runs roughtly in a north-south direction for a distance of approximately 130 km., varying in width from about 15 km to about 30 km. It can be divided into three areas: north Pare (max. alt. of 6,932 ft.), central Pare (max. alt. of 5,708 ft.), and south Pare (max. alt. of 8,080 ft.).

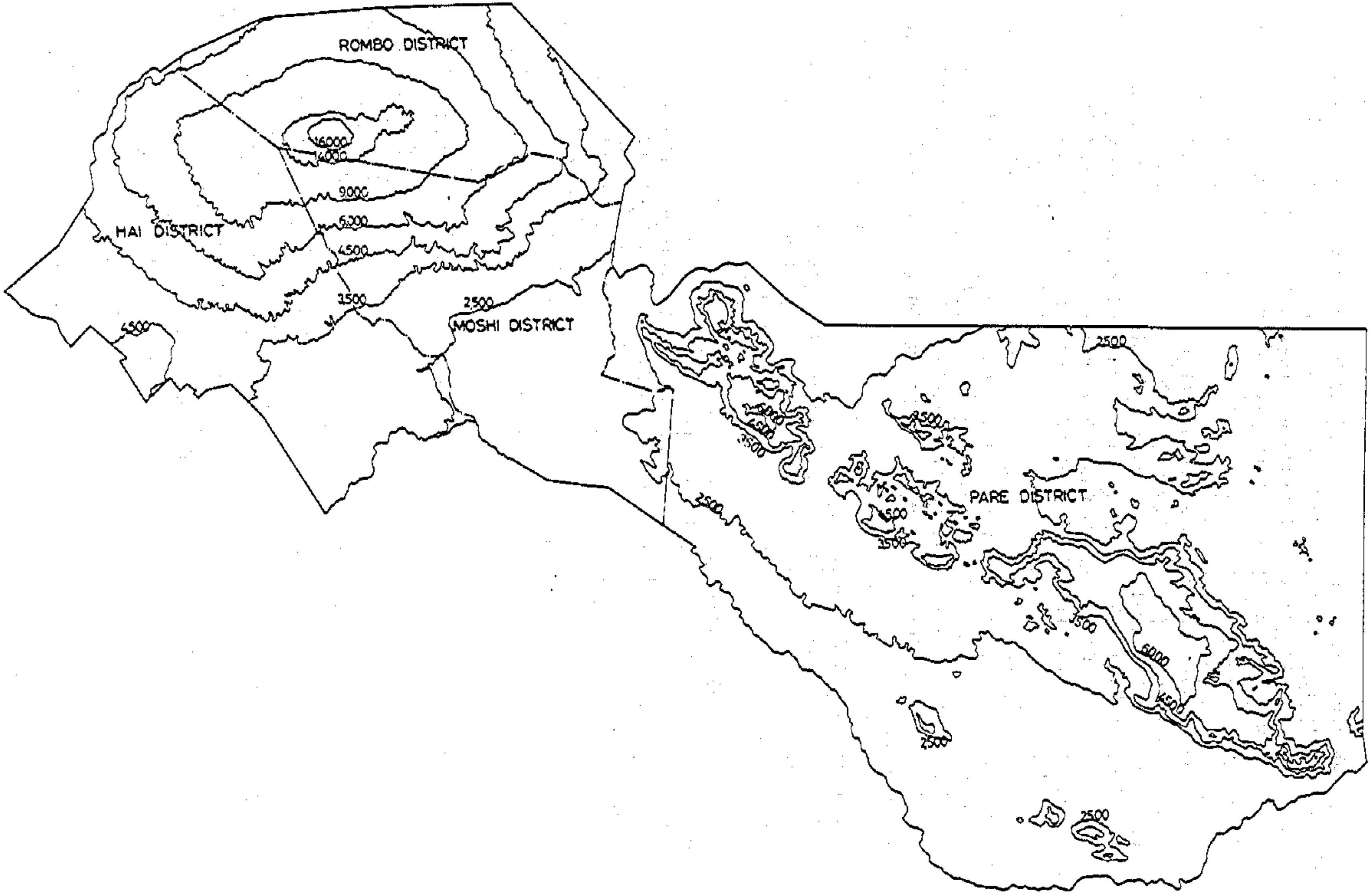
A feature of this mountain system is the fact that there is a clear dividing line between mountainous areas (above 3,000 ft.) and footlands. This is particularly true of the west side, where steep slopes of over 15 deg. constitute the boundary.

The ridge of the south Pare area and the whole of the central Pare area have a comparatively gentle slope of about 5 deg. The north Pare area, on the other hand, has a slope of about 10 deg. for the most part and a complicated terrain as a whole.

Since the ridgelines run in a north-south direction, rainwater runs off either eastward or westward. Furthermore, owing to the narrow width of the ridges and the limited area of streams for gathering water, the total length of swamps is only 5 km. Another possible reason for the shortness of the streams is the high rate of seepage of rainwater underground due to the fact that in mountain areas there are still relatively thick growths of vegetation in their natural state.

On either side of the Pare mountain system is an extensive footland zone with altitudes of under 3,000 ft. and slopes of about 0.3 deg., as in the case of the Kilimanjaro upper lowlands and lowlands. These footland zones are arid areas into which hardly any rainwater flows from the mountains. The footland zone on the west side of the mountains extends into the Masai Steppe and that on the east side into the steppes of Kenya. Although annual rainfall is below 400 mm almost everywhere in these zones, in the rainy season innumerable streams appear which run into the Pangani R. and Mkomazi. As for rainfall at other times than the rainy season, practically all of the water is lost through evaporation and underground seepage due to the gentle slope of the terrain.

ELEVATION (Fig.-1)



2.2 Climate

Although Tanzania lies in the tropics, her climate is only tropic tropical on the coast and in some low inland areas. Over the rest of the mainland the altitude ensures much cooler, drier weather than is usually associated with countries in these latitudes.

The country lies under the influence of the Inter-Tropical Convergence Zone, the Low Pressure Zone in which the north-east and south-west trade winds meet. This Zone falls about one month behind the movement of the sun, and as the sun goes from Cancer in September to Capricorn in March, the prevailing winds change from the south-east to north-east with the reverse from March to September. The air moves to fill in low pressure areas left by the sun's heat and the convergence brings a rainy season. So far as Tanzania is concerned, this general picture is considerably affected by the terrain and the presence of the Great Lakes but everywhere seasonal changer is related to the rains rather than, as in temperate countries, to the temperature.

The Kilimanjaro Region, although classified as a tropical savanna area, has considerable climatic diversity owing to the existence of Mt. Kilimanjaro, the ice cap of which stands out against the lower surroundings of tropical savannas.

One can hardly overemphasize the importance of climatic conditions, and particularly rainfall, in the context of the severe natural conditions to be found on the African continent, the respective lengths of the wet and dry seasons being of major relevance.

(1) Rainfall

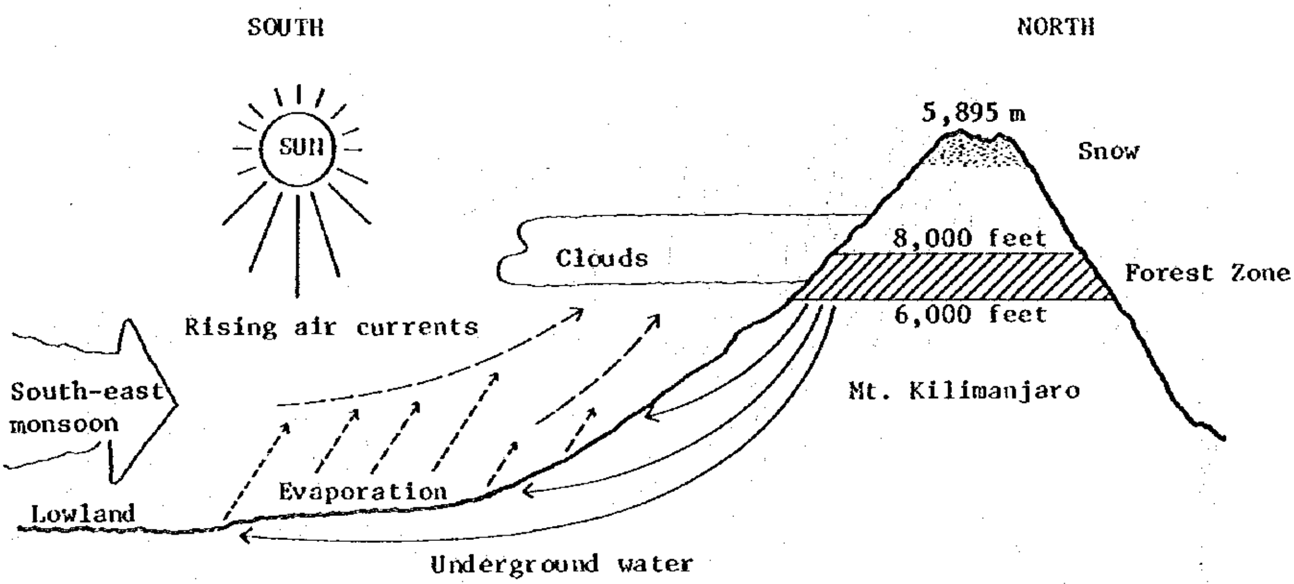
Water is a key factor in the development of Tanzania and clearly, therefore, rainfall, together with evaporation, are the most important climatic elements. The seasonal rainfall distribution in particular greatly influences agricultural practices. The major cause of rainfall in the tropics is convergence of air leading to an upward movement, and resultant cooling. The seasonal pattern of rainfall would seem therefore to be simply explained by convergence of air in the low-pressure trough and, in particular, at the meeting of the north-east and south-east airstreams (a feature often called the Inter-Tropical Convergence Zone or ITCZ).

In the Kilimanjaro Region the year can be divided into four periods with respect to the amount of rainfall:

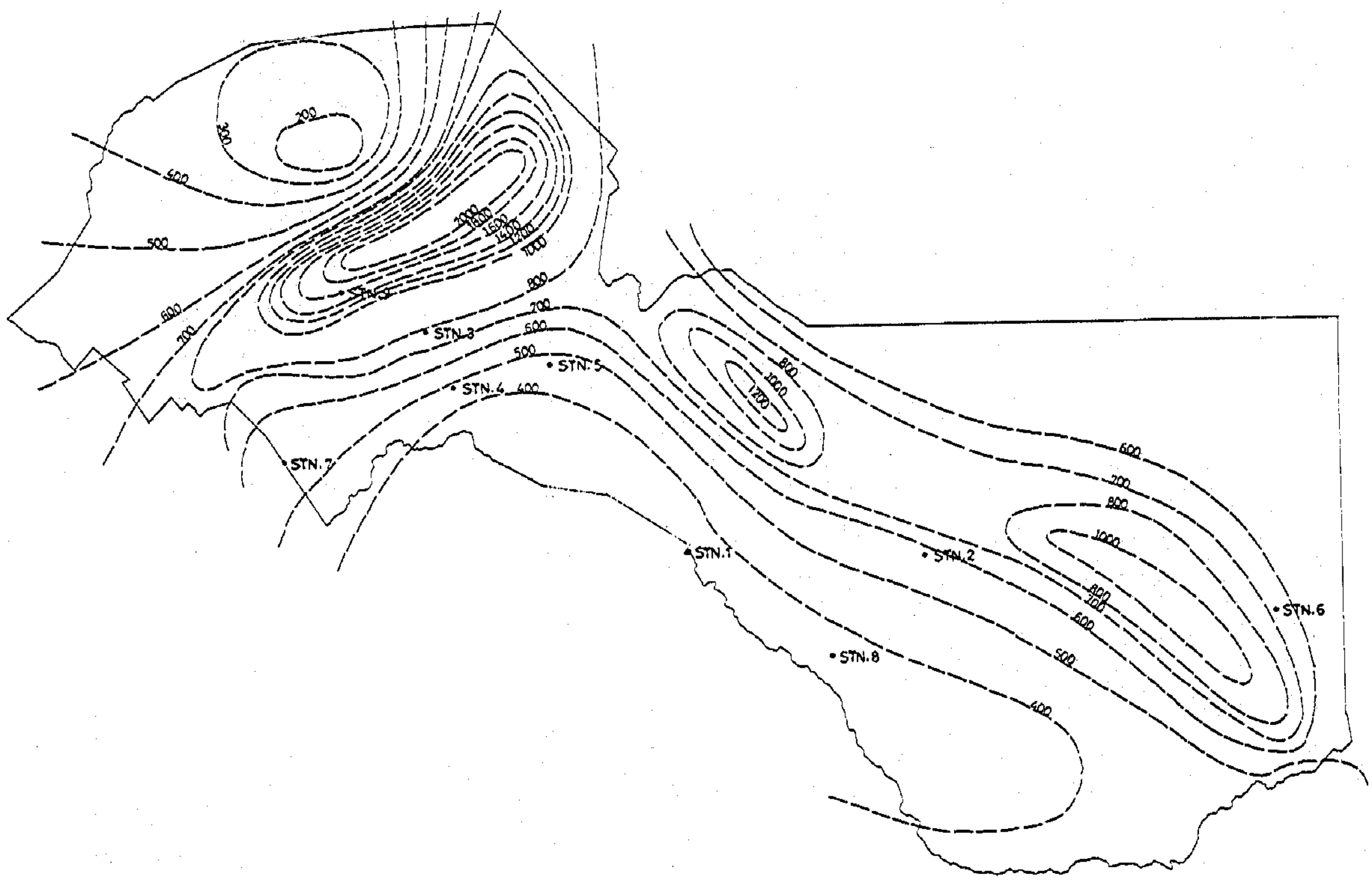
There are two rainy seasons--a major one in April-May and a minor one in Sept-Nov.--and two dry seasons, a major one in Dec.-Jan. and a minor one in July-Aug.

Besides varying amounts of rainfall in a particular season in different years, there is marked variation according to altitude and the direction of the slope in mountainous areas.

Most of the rain falls above 3,000 ft., the annual rainfall between 6,000 ft. and 8,000 ft. on the southern slopes of Mt. Kilimanjaro exceeding 2,000 mm. Even in the south Pare mountain area there is annual rainfall of over 1,000 mm at an altitude of 6,000 ft. A feature of the rainfall distribution is that more rain falls on the southern or southeastern slopes of the mountains than on the northern or western slopes.



ANNUAL RAINFALL MAP (Fig.-2)

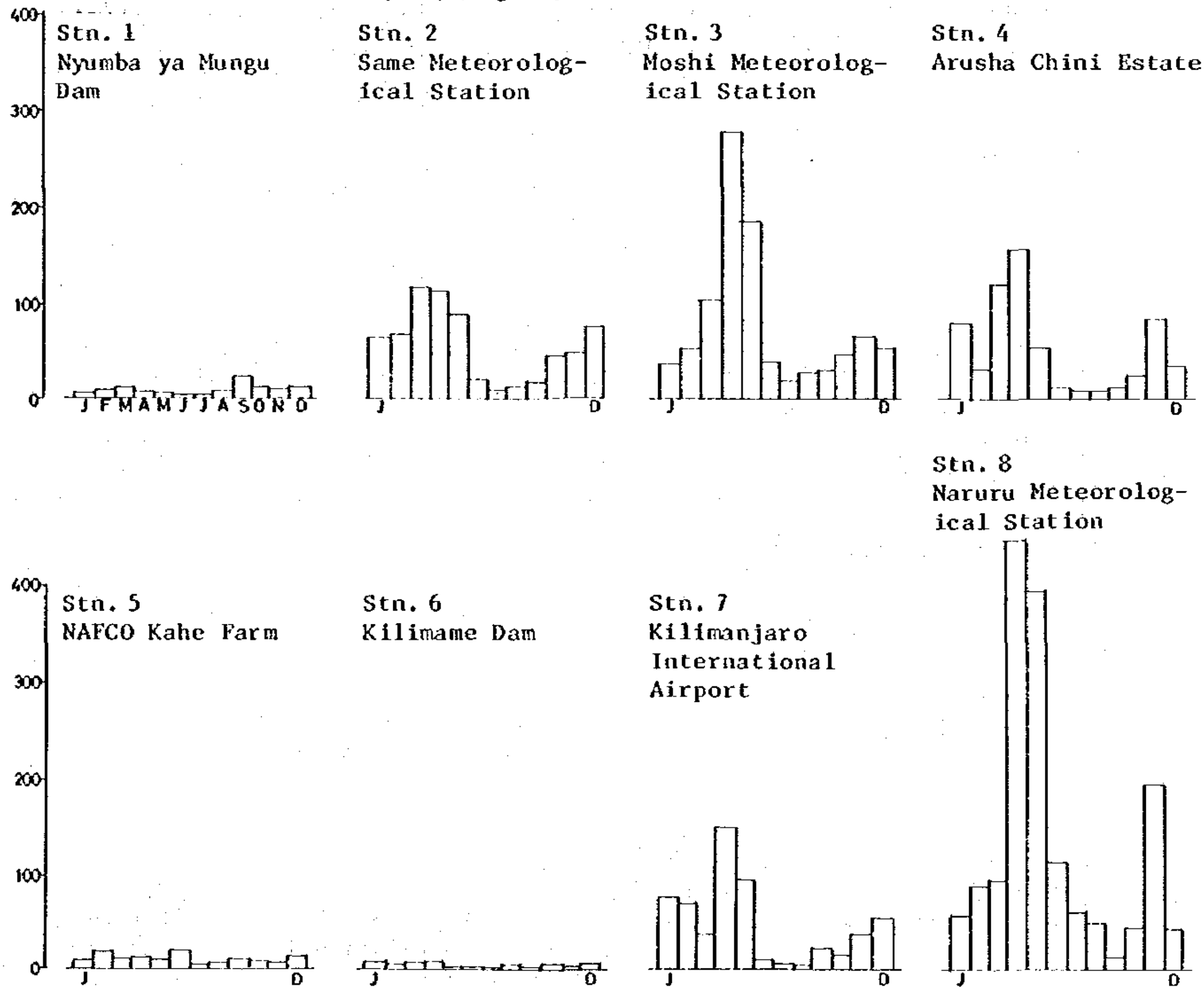


Rainfall and temperatures are closely related and have the same patterns of variation. It is very interesting to note the rough coincidence between the distribution of villages and the existence of certain climatic conditions (rainfall of over 500 mm and average annual temperature of below 25 deg.). The areas most suitable for human settlement are above 3,000 ft.

Also determined by a combination of temperature and rainfall are the types of vegetation. The same areas that are suitable for human settlement are areas where many kinds of trees and other vegetation grow well and where the land is suitable for agricultural use.

The southerly winds of the rainy season are stronger than the north-easterly winds of the dry season. It is these moisture-loaded strong southerly winds that cause so much rain to fall on Mt. Kilimanjaro and the Pare mountains during this time of the year.

AVERAGE MONTHLY RAINFALL (mm) (Fig.-3)



(2) Temperatures

Temperatures are closely related to altitude. The variation in mean monthly temperature is small (26°C-22°C) between the altitudes of 2,000 feet and 3,500 feet.

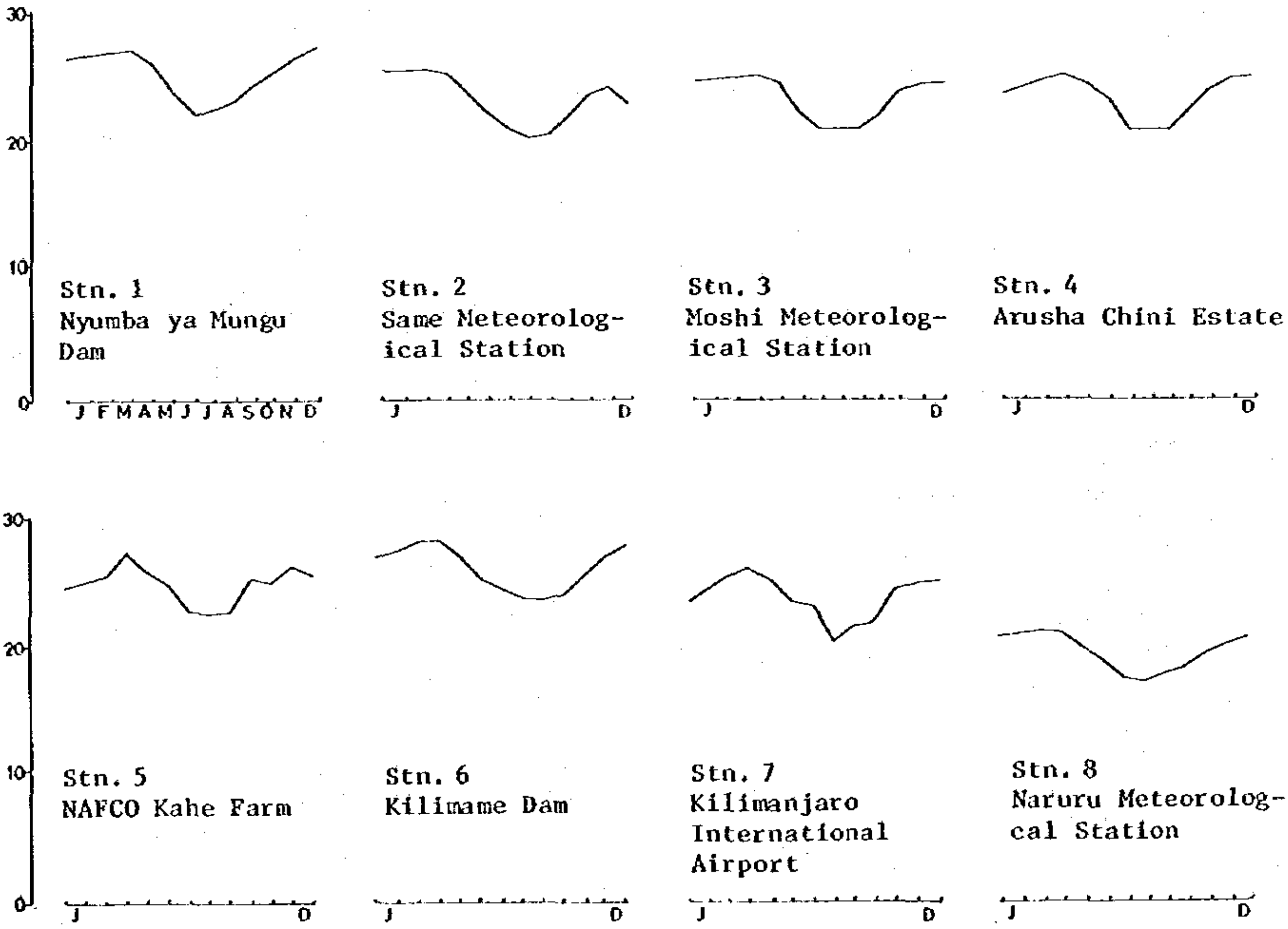
During the rains, extra cloud cover and evaporative cooling tend to reduce maximum temperatures. Cloud cover also tends to raise minimum temperatures.

The northeast monsoon also has a major influence on the distribution of villages, most of them being located on the southwest slope in order to be protected from it. In the Kilimanjaro region, the hot season lasts from October to March and is accompanied by high humidity.

But during the hot season the afternoon temperature can rise to 40°C and the weather becomes extremely oppressive.

The cool season runs from June to September and with mean temperature is 20°C-22°C and maximum temperatures of 35°C the weather is relatively pleasant at this time of year.

MEAN TEMPERATURE (c°) (Fig.-4)



(3) Sunshine

The number of hours of sunshine varies seasonally, rainy seasons having the lowest figures, and also areally, areas with low rainfall having the highest sunshine hours.

Thus at an lowland station such as Arusha Chini Estate with 580 mm of average rain fall/year, the average sunshine hours per year is 3,200, July and August having the maximum daily amounts (10 hours/day average) and January the minimum (7 hours/day average). Highland areas, which tend to be wet and cloudy, have comparatively low totals. Lyamungu, with 1,500 mm of average rainfall/year, on the southern slopes of Kilimanjaro, average sunshine hours/year, April having the least (5.3 hours/day) and October the most (9.1 hours/day).

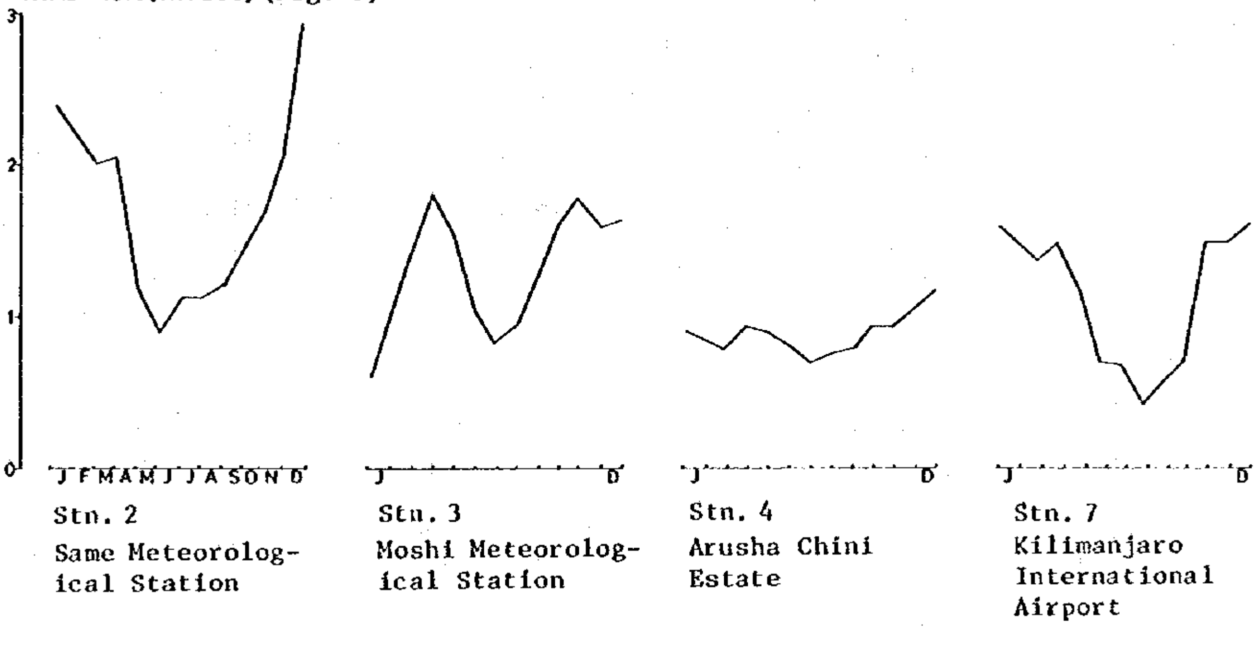
(4) Humidity

Monthly mean dew point temperatures show comparatively little seasonal variation, the range being about 4-5°C at a coastal station such as Dar es Salaam or a lakeside station such as Mwanza, and about 3-4°C at an inland station such as N.A.F.C.O. Kahe Farm. The wetter months have the highest values. The diurnal range in relative humidity is approximately indicated by the values at 0300 and 1200 GMT. Since relative himidity is determined both by the water vapour in the air and temperatures, the pattern of seasonal variation is not always simple, although the lowest values tend to occur during the dry season.

(5) Wind Run

Surface wind speeds are generally fairly low with a nighttime minimum. At lowland station during the night, speeds are normally less than 20 km/hour but during the day, 20-30 km/hour winds are quite frequent.

WIND RUN(m/sec) (Fig.-5)



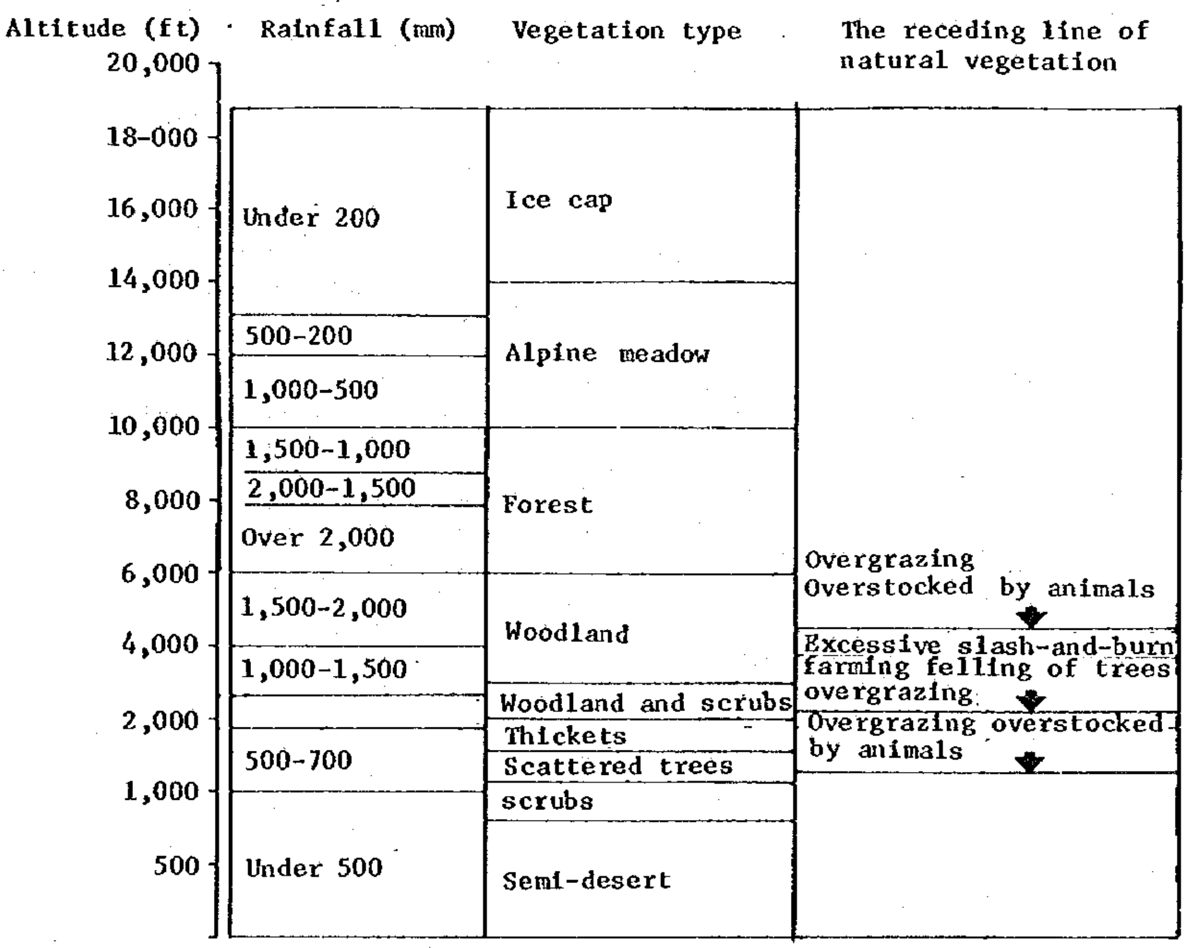
(6) Evapolation

From the practical point of view, an analysis of rainfall is of limited use without reference to the high evaporation rates. A rainfall of 750 mm per year is more than adequate for agriculture in many parts of the world. However, because of the high evaporation rates in Tanzania, this figure is taken by some people to be the limit below which cultivation is marginal, although of course much depends upon the type of crop and the seasonal distribution of rain. It has been pointed out above that only 20 percent of the country has a high probability of receiving 750 mm per year. In Kilimanjaro region, 30 percent of the region has a high probability of receiving 700 mm per year. Potential evaporation tends to decrease with altitude, this being predominantly a reflection of the variation of cloud cover with height.

2.3 Vegetation

The type of vegetation is determined for the most part by rainfall, temperatures (altitude), soils, etc. Also exerting a great influence, however, are such human activities as slash-and-burn farming, grazing of livestock, felling of trees, harvesting of grass, etc. The present distribution of vegetation is the result of a synthesis of all of these factors of both types.

Succession of Vegetation (Fig.-6)



(1) The Mt. Kilimanjaro Area

The alpine area above 10,000 ft. and with annual rainfall of under 150 mm has already been designated as a national park. Up to now it has escaped the influence of human activities, keeping its primeval natural environment intact.

Between 6,000 ft. and 10,000 ft. there is a forest zone, but the vegetation in that zone varies considerably because of the differing amounts of rainfall due to the different directions of the slopes. Although a small portion of the forest zone is being used for commercial purposes, the rest of it consists of primeval forests that have hardly been subjected to any human influence. Moreover, it is easy to imagine that in the past, before the population assumed its present proportions, such primeval forests extended all the way down to the 3,000 ft. line.

Between 4,000 ft. and 6,000 ft. there is a zone of villages and cultivated land which has been subject to the greatest human influence. Because of the highly dense land use, the primeval vegetation has practically vanished, having been replaced by plants raised for production purposes. This zone is therefore included in the vegetation category "scattered trees."

Below 3,000 ft. there are no forests, woodlands, or thickets to speak of, except for a very few places where underground water gushes to the surface. About all there is in the way of vegetation is scattered trees and scrub. This is largely due to repeated slash-and-burn cultivation and eventual abandonment of such fields as well as to overgrazing. Moreover, since only a very low percentage of the land has any green covering, the capacity to hold water is very low, and drying is very severe. In fact, with continuing regression of vegetation, there is the danger that this zone will become semi-arid.

(2) The Pare Area

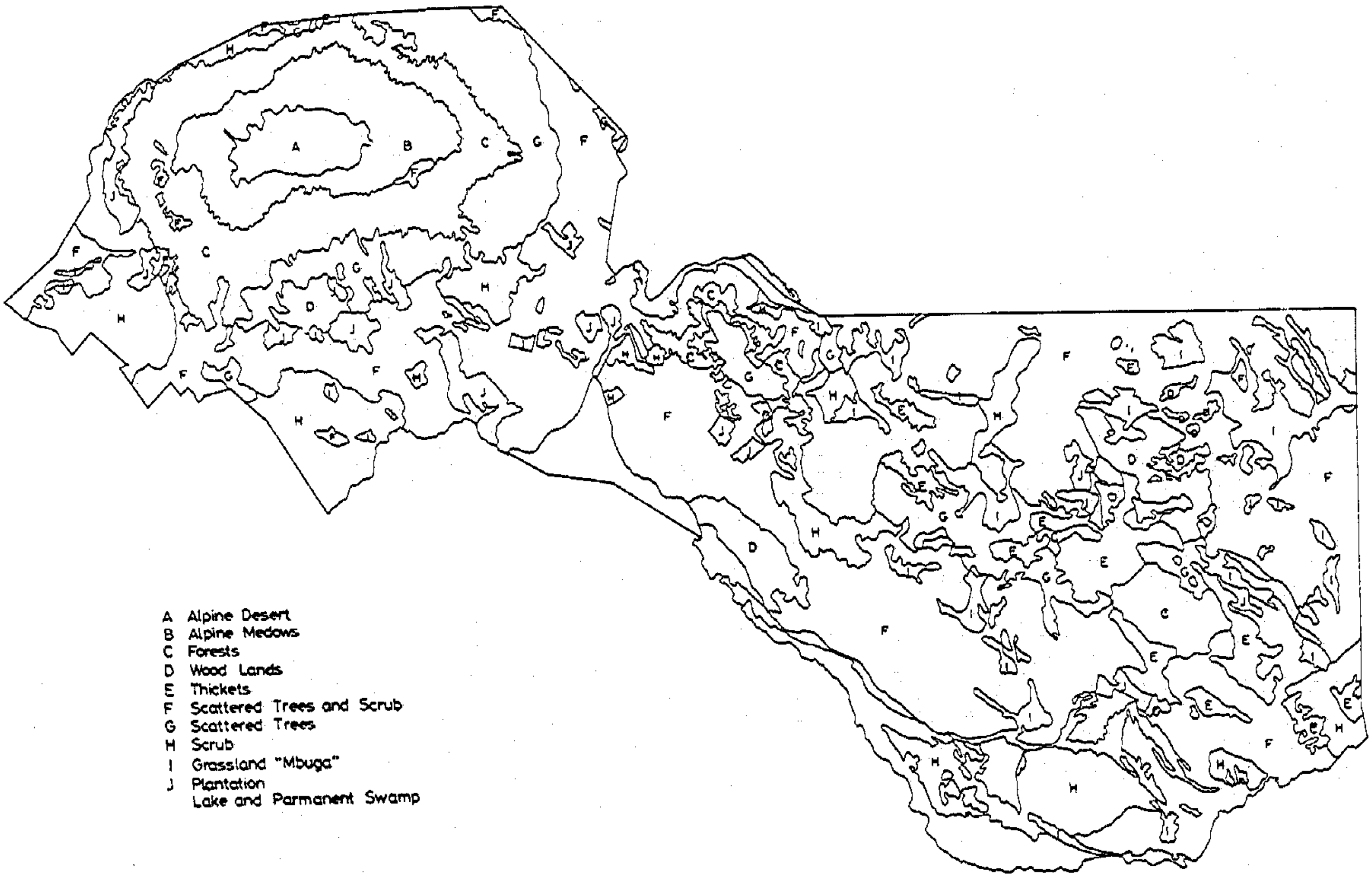
In the Pare area above 3,000 ft. there is a narrow forest belt running in a north-south direction. This belt, however, has been interrupted at many places by the encroachment of farmland and villages, and in the north Pare area the strip of forest along the ridge of the mountains has completely vanished. This area differs from the Mt. Kilimanjaro area in that the terrain is complicated, and the variation in type of vegetation is pronounced. Moreover, since the population is not very great, there has been little human influence on the natural vegetation, a particular feature being a considerable amount of thickets. Since on the east side of the Pare mountains the area between the highland and the footland areas is more extensive than on the west side, it receives a greater amount of rainfall and has some woodlands. On the west side of the mountains, however, about all there is scattered trees and scrub all the way to the Pangani R. since dryness is very severe. In comparison to the Mt. Kilimanjaro area, the Pare area has a higher degree of natural vegetation and a greater variety of tree types.

Let us now consider the features and tree types of each of the categories of type of vegetation in the Kilimanjaro Region (see Natural Vegetation Map).

Breakdown of the Area by Types of Vegetation (Table-1)

	Hai	Moshi	Rombo	Pare	Total (km^2)
Alpine district	38.0	29.5	159.0	-	226.5
Alpine meadows	200.0	730.0	435.0	-	708.0
Forests	430.4	172.0	394.9	1,085.4	2,082.7
Woodland	67.0	-	-	20.0	87.0
Thickets	-	-	-	489.5	489.5
Scattered trees and scrub	429.0	717.0	135.0	5,073.0	6,354.0
Scattered trees	54.3	328.6	282.0	71.6	736.5
Scrub	552.6	80.7	26.0	228.6	887.9
Grassland	22.2	1.2	-	705.8	809.2
Plantation	315.5	203.7	0.6	56.8	576.6
Lake and permanent swamp	0.8	158.5	2.5	89.3	251.1
	2,109.8	1,764.2	1,435.0	7,900.0	13,209.0

NATURAL VEGETATION MAP (Fig.-7)



(3) Description of Types of Vegetation

(i) Alpine Meadow

This zone consists of upland moorland from 14,000 ft. to 16,000 ft. and moorland from 10,000 ft. to 14,000 ft. Here rainfall is less than 300 mm a year, temperatures are low, and the vegetation is chiefly alpine. The trees are less than 1.5 m tall, and most of the vegetation is of the ground-cover type.

The following are the kinds of trees to be found here in descending order of height:

Erica arborea
Philippia trimera ssp kilimanjarica
Adenocarpus mannii
Agroshis producta
Festvca sp.
Koeleria gracilis
Deschampsii sp
Exotheca abyssinica
Philippia excelsa
Hypericum revolutum

(ii) Forests

Forests extend in a belt-like fashion, the width of the belt varying, between 6,000 ft. and 10,000 ft. on the slopes of Mt. Kilimanjaro and upwards of about 4,000 ft. in the Pare mountains.

KITENDEN

Natural
Juniperus procera (pencil cedar)
Olea chrysophylla (olive)
Afforestation
Pinus patula
Cupressus lusitanica

Natural
Above 8,000 ft.
Juniperus
6,000-8,000 ft.
Cassipourea malosana
Eckebergia ruepelliara
Podocarpus milanjianus
Fagaropsis angolensis
Blow 6,000 ft.
Juniperus procera
Olea chrysophylla
Afforestation
Pinus patula
Pinus radiata
Cypressus lusitanica

KIBONGOTO

KIBO 5,895 m

MKUU

Natural
Ocotea usambarensis (E. African comphor)
Podocarpus milanjianus (Podo)
Hagenia Abyssinica
Rapanea rhododendroides
Eckebergia rueppelliana
Afforestation
Pinus elliottii (slash pine)
Pinus teada (loblolly pine)
Pinus radiata (Monterey pine)

(iii) Woodlands

Woodlands are to be found quite extensively at altitudes of over 4,000 ft. where annual rainfall exceeds 700 mm. The woods are fairly thick, with three different types, evergreen trees being the most numerous. Like the forest zone, the woodlands are important in terms of natural collection of water and production of fertile soil. The height of the trees is 15-20 m.

Typical Cross-section of the Woodland Area (Fig.-8)

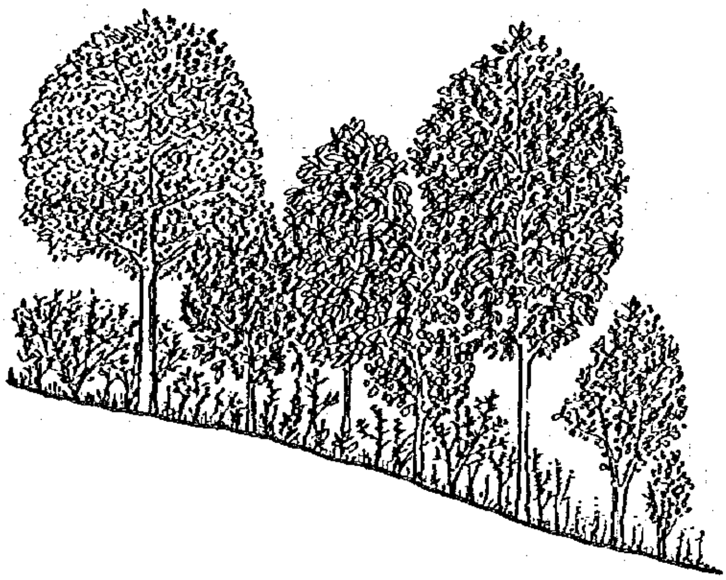
(iv) Woodland and Scrub

Here the growth of trees is not so thick because of the felling of trees and former cultivation, and scrub predominates. The water collection and fertile soil production functions are not as important as in the case of the more typical woodland type. The height of the trees is 10-12 m.

(v) Thickets

Thickets are to be found primarily near the 4,000 ft. line in south Pare where the rainfall is in excess of 700 mm and where population density is relatively low. The growth of the trees is quite thick. The growth is of three types, with a high rate of green coverage of the ground. The water collection function therefore figures here as well. The trees, which grow to a height of 7-10 m, are about half and half evergreen and deciduous.

Typical Cross-section of the Thicket Area (Fig.-9)



Main trees

Commiphora schimperi
Comiphora campestris
Acacia bussei
Acacia etbaica

Cassia sp
Cordia sp

(vi) Scattered Trees

The distribution of this category of vegetation is mostly below 3,000 ft., as is that of scrub. The annual rainfall is below 500 m. Accordingly, the growth density of the trees is low, and there is a high incidence of deciduous trees of the acacia family, which are able to survive under dry conditions.

Typical Cross-section of the Scattered Trees Area (Fig.-10)

Main trees

Acacia tortilis
Acacia etbaica
Acacia senegal
Boscia salicifolia
Commiphora
Melia volkensii
Themeda triandra
Heteropogon

(vii) Scrub

This vegetation category is to be found in very dry areas with annual rainfall of under 500 mm, where there are very few trees, i.e., on what is known as the steppes. Because of overgrazing and slash-and-burn cultivation, some parts of these areas run the risk of becoming semi-desert lands. The extreme dryness makes it possible for only a limited number of vegetation types to survive, and of these, many have thorns or thick leaves.

Main trees

Commiphora schimperii
Acacia bussei
Cordia rothii
Cassia abbreviata
Maerua spp

2.4 Soils of the Kilimanjaro Region

(1) Soils on the Slones of Mt. Kilimanjaro

As can be seen in the soil map, the soils on the slopes of Mt. Kilimanjaro very in strip-like fashion according to the contour lines as a reflection of climatic conditions. The volcanic lava and ashes on the slopes, which represent the parent materials of the soils, are also of may rock types and therefore influence the soils in many different ways. Most of the lava from Mawenzi Peak, which covers wide areas of the eastern slopes, is rich in calcium and magnesium minerals, and that from Kibo Peak is for the most part rich in potassium minerals. Furthermore, there are a large number of volcanic cones with centers in the Rombo, Kilema, Kibongoto, and North Shira areas and representing piles of volcanic pyroclastic rock consisting of scoria and ash, Since scoria and ash are highly porous, their weathering is rapid, and the soils of which they are the parent materials are deep.

In the upper zone from the southern to the eastern slopes of the mountain are distributed podsolic soils, humic ferralitic soils, and humic ferrisols. Because of the high amount of rainfall the bases of these soils are subject to leaching, which means that they have an acid reaction.

On the forested slopes along the west and north sides of the mountain there is little rainfall and hence no leaching of soil bases. Accordingly, the soils there are eutrophic brown soils with higher basic content. Because of their good degree of base saturation, these soils, which are also distributed west of Moshi and around Himo and Trakea, have a very nearly neutral reaction.

Ferruginous tropical soils are distibuted widely on the south and eastern slopes as well as over a small area contiguous to the West Kilimanjaro forest belt. At higher altitudes they are coupled with a moist climite, and at lower altitudes they border on areas with semi-arid climatic conditions. Their organic content is only moderately high, and their basic content, too, is not greater than average. They have a slightly acidic reaction. Generally speaking, their lower layers have a high clay content, which would appear to account for their low permeability and susceptibility to erosion.

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Ferruginous soils that have resulted primarily from colliuvial sedinentation are distributed in the area along the Arusha-Himo road and contiguously to the abovementioned soils, with Moshi just about at the center of their distribution. Since the rainfall here is under 1,000 mm, the base saturation of the soil is high, with pH values of over 7.0. In this soil belt irrigation is indispensable if crops are to be grown in the dry season.

Along the shores of Lake Chela in lower Rombo, along the lower western slopes of the mountain, and along the Moshi-Arusha road are distributed reddish brown soils of semi-arid areas, the rainfall there ranging from 500 mm to 750 mm.

In a broad area around the point on the Moshi-Arusha road from which another road branches off to Sanya Juu are distributed lithosols which derive chiefly from lava from Mt. Meru and which are stony and shallow. Although there is considerable cultivation of maize and beans in these soils, the limited rainfall and the relatively poor quality of the soil set severe restraints on agricultural development.

(2) Soils of the Pare Mountains

The soils of the North and South Pare mountains derive from metamorphic rock, chiefly gneiss. The western slopes of these mountains are very steep for most part, with basic rocks lying shallowly. Here are to be found shallow lithosols containing splinter from disintegrated rocks of this type. On the upper slopes there is a wide distribution of humic ferrisols derived from parent materials different from those of the humic ferrisols of Mt. Kilimanjaro. Although the rainfall is only in the range of 800-1,000 mm, the base saturation of the soil is generally quite low because of rather advanced leaching, which means that the soils have an acidic reaction. In comparison to the same type of soils on the slopes of Mt. Kilimanjaro, the soils here seem to be rather deficient in potassium content. It will therefore be necessary to use fertilizers in order to raise agricultural producttivity in the Pare mountains.

(3) Soils in Lowlands of Pare

In the Pare footlands there is a wide distribution of ferruginous soils, which resulted from old colluvial sedimentation and long weathering of their parent materials. Generally, their their base saturation is low, and since they have only moderate clay content, they would seem to have relatively good permeability. These soils are being widely used for cultivation of sisal, but deserted sisal estates are also to be found in many localities. Although it will probably be possible to make use once again of the soil of such estates in spite of considerable erosion of the surface, the soil conditions will first have to be surveued in detail by individual area and other natural conditions will have to be taken into account before determining what crops can be cultivated on such soils. Needless to say, continued abandonment of these estates is not advisable from the standpoint of soil preservation as the soil will only become more eroded.

Strips of swampland are located along the shore of Lake Jipe, along the Kifaru R., which flows from it, and near the upper banks of the Nyumba ya Mungu dam reservoir. Since the soils hrtr str unfrt esyrt , they are subject to strong gleying, and their lower strata have a bluish gray tint. They are classified as"gley soils on papyrus swamp." At the present time it is in any case, they do not cover a very wide area. There are also gley soils along lower lying stretches of the Mkomaji R. in South Pare which are effected by underground water. These soil units are shown in association in the diagram. Although there is already some paddy rice cultivation in this area,in the course of further development it will be necessary to provide drainage facilities,use good quality irrigation water for the removal of salts, and prevent salts from rising to the surface.

(4) Soils in Lower Moshi

In lower Moshi on all sides of Kahe Junction there lies an extensive alluvial plain. For the most part, the parent materials of the soils of this plain represent sediments from the slopes of Mt. Kilimanjaro, but along the lower reaches of the Kikuletwa R. there are soils which represents sediments brough from Mt. Meru by the river that flows into it west of the Tanganyika Plating Company (T.P.C.) In this area the rainfall is 500-750 mm. Upstream of the railroad track serving the T.P.C. sugar factory there are brown soils characteristic of semi-arid areas, and downstream there are brown calcimorphic soils with a secondary calcic hardpan. The distribution of the former also extends to the Kifaru sisal estate and the Sanya Chini area, and that of the Kileo area, the hardpan being close to the surface downstream around Mikocheni. As for the brown soils characteristic of semi-arid areas, they have a pH of 6.5-8.7,an electric conductivity of 15-255 micromhos/ cm2, and a salt concentration that is not all that high, which clearly marks them as promising for agricultural development through the use of irrigation water.

Both the pH and the salt concentration of the brown calcimorphic soils with secondary hardpan are high, which means that if they are to be agriculturally developed, it will be necessary to remove the salts with good quality irrigation water. Cultivation of fodder hay is effective in terms of such soil improvement, and prosently lucerne is being grown on the NAFCO estate. Cultivation of such grasses is effective in terms of preventing the rise of salts to the surface, and plowing the grass into the ground can be expected to enrich the soil in terms of vegetable nutrition as a source of nitrogen. Furtherm re, in view of the development since it would be extremely difficult to develop calcimorphic soils with a hardpan on the surface.

Dark brown soils and grayish brown soils are distributed along the Mua and Kifaru rivers around the Miwaleni Spring area east of lower Moshi. The dark brown soils are also distributed near the Weruweru R. west of lower Moshi. In all probability, these soils have been affected by river water. Paddy rice is being cultivated in areas with dark brown soils along the Rau R. near the outskirts of Moshi Town. These soils have a pH of 6.1-7.8 and a salt concentration of 80-525 micrombos/cm2, but it will not be necessary to remove salts. If these soils are to be developed, however, it will be absolutely necessary to have complete provision of drainage facilities. The fact that the gray brown soils have been even more affected by water than the dark brown soils is evident from both the natural vegetation and the soil color. Further investigations will have to be carried out before it will be possible to determine the possibilities with respect to use of these soils.

(5) Soils in the Pangani Valley

In terms of association of alkali and saline soils with vertisols, the soils in the Pangani Valley have been classified into recent alluvial plain soils (Ja), volcanic lacustine sediment soils (Jb), a-luvial plain soils (Jc), reddish brown to brown soils characteristic of semi-arid areas and which derive from colluvial sediments and limestone (Jd), associations of these with lithosols (Je), and so on. The association Jc-Je is also distributed in the Pare footlands.

An FAO soil investigation report has classified the land in the Pangani Ualleg as follows according to suitability for irrigation-supported agriculture:

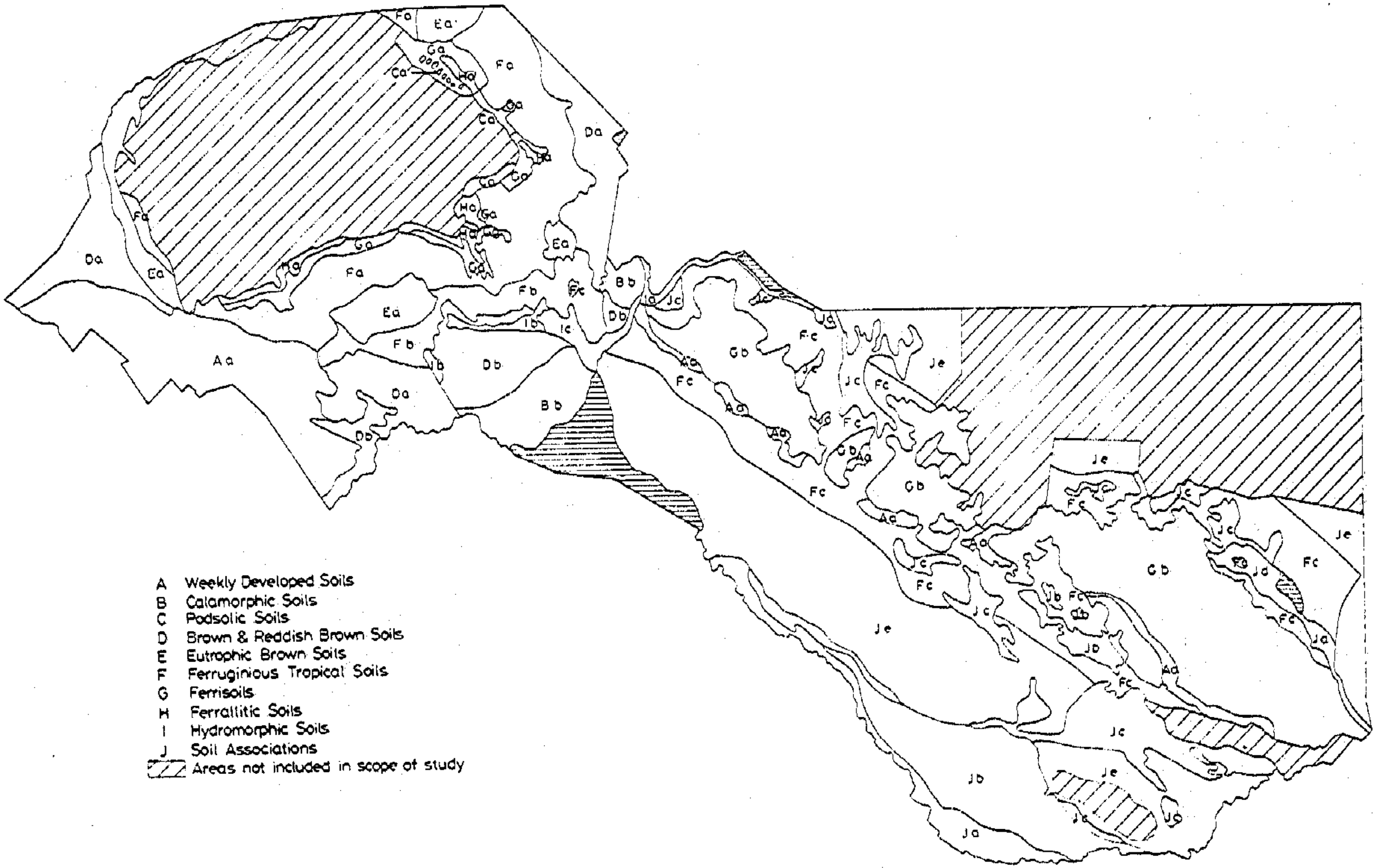
Class-II land (3,000 acres) -- suitable for intensive irrigstion
Class-III land(13,750 acres)-- irrigation difficult considering

the location of the land .
Class-V land (113,150 acres) -- irrigation suitability not yet determined
Class-VI land (97,000 acres) -- not suitable for irrigation

In the soil map attached hereto the 3,000 acres which are suitable for irrigation are included within the Jb association.

Most of the soils in this valley are either salt or nonsalt alkaline soils. Development of such soils will generally entail removal of salts and treatment with chemicals such as gypsum. Considering, however the fact that in many cases. these soils have an impermeable layer, it will be no easy matter to develop them sucessfully.

SOIL TYPES (Fig.-11)



2.5 Geology of the Kolimanjaro Region

Essentially the geology consists of a pile of Neogene volcanic products and some interbedded sediments accumulated on an eroded surface of Precambrian metamorphic rocks.

(1) Neogene

The date of the commencement of volcanicity is uncertain. Further north in Kenya the earliest known Neogene volcanics have been dated by isotopic methods as 13 to 15 million years old, namely, of Miocene age. The earliest Kilimanjaro volcanics can only be dated as Mio-Pliocene and activity has continued through Pleistocene into Recent times with diminishing frequency and importance. Activity is now limited to local fumaroles. From an early stage, activity has been concentrated around three major centres, which now correspond to the three main topographic summits of Shira. Kibo and Mawenzi.

(i) Shira. - Shira, the oldest centre, is a relatively simple strato-volcanic cone with a large eroded crater.

The cone is built mainly of lavas, although some pyroclastics are present. The following rock associations are seen:-

ankaramite olivine basalt - trachybasalt - trachyandesite
basanite - nephelinite.

In the lower exposed part olivine basalts are important, but in the upper part the more advanced differentiates predominate.

On the southern part of the Shira Plateau rises the conical hill called Platzkegel. This degraded remnant of a major vent-infilling occupies a roughly central position with respect to the Shira structure. The vent-infilling is mainly composed of basaltic agglomerate, with some basic lavas, and is penetrated by intrusions of doleritic and exxexitic nature.

South-east of the Shira Plateau, in the upper parts of the Kikafu Valley, the "Amphitheatre" sediments are exposed. These alluvial deposits contain a wide variety of pebbles, including ijolitic rocks not seen elsewhere on the mountain. They post-date the last activity of Shira.

(ii) Mawenzi.- The highly eroded rocky mountain Mawenzi, with its highest point at Hans Meyer Peak, 16,896 feet, is a complex erosion residual between intersecting corries. Mawenzi is a complex volcano with two major centres visible, giving rise to two groups of volcanic rocks. Both centres have been extinct since the early Pleistocene.

The Neumann Tower group comprises a succession, mainly of lavas, showing the following range of rock type: ankaramite - olivine basalt - asphyric and feldsparphyric olivine trachybasalt and trachybasalt. The lavas dip out from a complex vent, with an agglomeratic infilling and intrusive bodies, situated at the Neumann Tower. These lavas represent the earliest visible activity of Mawenzi, obscured by later parasitic lavas and blanketing forest. Thus, although their distribution is probably extensive, correlation with lavas below the forest line is conjectural.

The Mawenzi group is so named because all the principal peaks of Mawenzi are built of its members. It is a sequence of effusions, including considerable amount of pyroclastic rocks, showing the following range of types: olivine trachybasalt and trachybasalt - olivine trachyandesite and trachyandesite - basalt - andesite. The most characteristic varieties are feldsparphyric and carry numerous phenocrysts of andesine bytownite with a thin platy habit (length/thickness ratio up to 20-1); they may exceed one inch across.

Mawenzi and Neumann Tower lavas extend down the slopes on to the plains crossing into Kenya and are exposed in the walls of Lake Chala; the groups have not been separated in these regions. They average between two and three feet thick and are relatively hard and give rise to pinnacles and ridges.

(iii) Kibo. - The central and largest of the Kilimanjaro centres is a "puy" shaped volcano the dome of which has been obliquely truncated by collapse resulting in the forma -tion of a caldera one and a half miles in diameter. The highest portion of the caldera rim is on the south and culminates in Uhuru Peak, 19,340 feet high.

Within the Inner Crater lies the Ash Cone and its vent, termed the "Ash Pit", the latter 370 yards in diameter and 425 feet deep. The Inner Crater is the site of the last activity of the mountain. The southern slopes of Kibo are dissected by glaciated valleys.

The lavas of Kibo show strong alkaline differentiation and range from trachyandesite, through trachyte to nepheline-rich phonolite. A wide range of these rock-types occurs, and a detailed succession is well-established, especially in the south-west. The lava flows of Kibo flooded westwards almot completely over Shira but to the east they were strongly deflected to north and south by the peak of Mawenzi.

The maximum observed thickness of the several lava groups, each of which may comprise scores of individual flows, is given in the following account.

The succession of lavas has been determined as follows:

Inner Crater group
Caldera Rim group
Small-rhomb porphyry group
Lent group
Rhomb porphyry group
Upper rectangle porphyry group
Upper trachyandesite group
Lower rectangle porphyry group
Lava Tower trachyte group
Lower trachyandesite group

Most of the Kibo lavas seen belong to the earlier part of the Pleistocene but the small-rhomb porphyry group and Caldera Rim group erupted in the latter half of the Pleistocene and the Inner Crater activity is Recent.

The lower trachyandesite group (60-plus m 200-plus feet) is the oldest set of lavas exposed. It has a restricted outcrop near the Lava Tower and in the Umbwe Valley at 13,500 feet to 15,000 feet. Lithologically the lavas resemble the upper trachyandesites.

The Lava Tower trachyte group (300 feet) is seen only in a few places high on the south-west flanks of Kibo. Lithologically the lavas are green, fluidal, fissile and are often conspicuously xenolithic. Petrographically the lavas are aegirine-rich trachytes.

The lower rectangle porphyry group (2,000 feet) is also exposed in limited areas on the south-west flanks. Petrographically the lavas are trachyandesites, differing from the upper and lower trachyandesites in the nature of the plagioclase mega-phenocrysts.

The upper trachyandesite group (200 feet) and the upper rectangle porphyry group (1,000 feet).
These two groups have a much wider distribution, again mainly in the west and south of Kibo. Lavas on the northern slopes of the mountain approaching the Amboseli Plain are probably to be correlated with the upper trachyandesite group, as are those in a small exposure west of the Karanga River at the southern base of the mountain. The upper rectangle porphyries extend westward on to the Shira Plateau and are also seen in valley sections in the 3,000 to 4,000 feet level east of Machame and at the Weru-Weru and Kikafu rivers.

The upper trachyandesite group is separated from the underlying lower rectangle porphyry group by an important erosion surface.

Above the upper rectangle porphyry group is developed a spectacular rhomb porphyry succession more than 3,000 feet thick comprising the rhomb porphyry group, the small-rhomb porphyry group and the Caldera Rim group. The name "rhomb porphyry" has been used essentially as a field term to describe lavas ranging in composition from trachytes to phonolites with mega-phenocrysts of alkali feldspar showing rhombic cross-sections;

The rhomb porphyry group (2,000 feet). The lavas of this group are characterized by abundant phenocrysts of alkali feldspar up to one and a half inches in length. It must have been the most widely distributed of all Kibo lavas since flows of this type pass off the sheet boundaries to the north, north-west, and probably south of the mountain. Individual flows, which may exceed 50 feet in thickness, are known to extend more than 25 miles from their probable point of origin. They moved by characteristic tunnel-flow mechanism.

Locally in the region of the snouts of the Penck and Credner glaciers the rhomb porphyry is underlain by the distinctive Penck rhomb porphyry (400 feet) with small, very sparse feldspar phenocrysts in a very basic matrix. Elsewhere the rhomb porphyry succession commences with the Weru Weru agglomerate which is 80 feet thick in the Weru Weru Valley at 4,200 feet altitude. Neither of these two units has extensive outcrops and they have been included in the rhomb porphyry group on this map.

The Lent group (1,000 feet). In many parts of Kibo the lavas of the rhomb porphyry group were succeeded, after a lengthy erosion interval, by aphyric trachyandesites, trachytes and phonolites. These form extensive flows on the northern and southern flanks of the mountain, and appear to have originated as flank eruptions from fissures and centres. The most prominent centre, the Lent Peak north-west of Kibo, is an impressive collapsed dome.

The small rhomb porphyry group (700 feet). In the central region the rhomb porphyry group is succeeded by a group of lavas later in age than the Lent group which are characterized by abundant, euhedral rhomb-shaped phenocrysts of relatively small size, generally less than half an inch in length. Sparse, small mega-phenocrysts of nepheline are also commonly present.

Analcime syenite (300-plus m). Within the central portion of Kibo, exposures in the Great West Notch show that the rhomb porphyry group is succeeded by a considerable thik-ness of analycime-syenite, the bottom of which has not been seen. This syenite contains small rhombic phenocrysts of alkali feldspar, and in other ways it resembles closely small rhomb porphyry. It is, in fact, thought to be a portion of the small rhomb porphyry magma which was extruded under presumed thin cover as cauldron subsidence proceeded, and cooled slowly by virtue of its large volume.

Kibo "lahar". A boulder deposit covers a large area of the plains south-west of Moshi at heights of below 3,000 feet. In places it shows the mounded topography characteristic of "lahar". This deposit was formed by enormous debris flows during the development of the Kibo Barranco which took place at some period subsequent to the formation of the small-rhomb porphyry group and before the outpouring of the Inner Crater lavas.

The Caldera Rim group (630 feet) is a group of rhomb porphyries with abundant, large, well-formed mega-phenocrysts of alkali feldspar accompanied by sparse to abundant mega-phenocrysts of nepheline which may approach one inch in diameter. These lavas formed a series of flat-lying flows filling a caldera which formed in the small rhomb porphyry lavas. Later they spilled over the sides forming large isolated channel flows on the flanks of Kibo, especially on the north and north-east slopes, where some extend to the edge of the map.

The Inner Crater group (425+ feet) comprises nepheline-rich aegirine-phonolite lavas with small mega-phenocrysts of well-shaped nepheline and more irregular ones of alkali feldspar. These are the last groups of lavas to have been erupted and are post-Pleistocene in age. Their low cone fills the present caldera which formed at the end of the Caldera Rim group.

Shira and Lagumishera zones. From the west to the north of Shira lies an area with more than 100 cones, generally more dispersed than in the Rombo zone. The widest range of pertrographic types known in the parasitic activity is found here and both pre-rhomb porphyry and post-rhomb porphyry activity is known. The North Shira zone forms a well-defined and narrow raised linear zone extending from the North Shira Plateau to the plains near Sinya. The lavas are chiefly andesites and trachytes. The groups of cones lying to the south and north of this zone have been ascribed, for ease of description, to an Engare Nairobi zone and a Lagumishera zone respectively.

Present Volcanicity - Residual volcanicity is now confined to Kibo, where it is expressed by fumarolic activity associated with the Inner Crater ring fractures. The fumaroles are believed to indicate waning activity, but they may represent a dormant stage in the volcanicity.

Meru "lahar" - West of Shira the Kilimanjaro lavas pass under the region of a great "lahar" field extending westwards to Meru. This "lahar" was formed in recent times by the collapse of the east wall of the crater on Meru. In general, north of the Arusha-Moshi road the Meru "lahar" forms mounded topography whilst south of the road outwash from the lahar forms a more even plain. The "lahar" deposit consists of boulder beds, over 80 feet of which are visible in the Sanya River sections.

Alluvium. - Most of the valleys of Kilimanjaro have alluvial terraces on their lower parts with boulder beds conspicuous among the deposits. These terraces coalesce on the plains north and south of the mountain to form wide spreads of sandy and gravelly deposits. The Pangani deposits in the south consist mainly of sands. The Kikuletwa and Sanya rivers have narrower alluvial plains, and small areas of lacustrine and alluvial deposits have formed west of Shira where the drainage of the Sanya River was temporarily blocked by the Meru "lahar". Extensive alluvial sand and gravel deposits surround the lacustrine deposits of Amboseli.

Red soils. - South of Kirua are extensive alluvial deposits of sand clay and conglomerate with secondary limestones, all distinctly red in colour. Similar deposits have a widespread but irregular occurrence on the lower slopes of Kilimanjaro, west of Shira and east of Mawenzi. In places they reach thicknesses of 200 feet. Outcrops of Precambrian rocks are all surrounded by fringes of duricrust which may be highly calcareous in places. Surface limestone is present on some of the parasitic cones in the Shira Zone and locally elsewhere.

(iv) Parasitic Cones. - Associated withtthe Kilimanjaro volcanicity are small but numerous adventitious cones. Generally they are situated on the lower flanks, extending in zones down to the plains, but they also occur on the Saddle at more than 14,000 feet. They consist mainly of scoria and ash, but several have produced lava flows forming extensive fields as in the Upper Rombo and North Shira zones. Rock-types identified are: ankaramite - oceanite - olivine basalt - trachyandesite - phonolite - basalt - andesite - trachyte.

The older pre-dates the rhomb porphyry group but may post-date the upper rectangle porphyry group. In addition much older centres have been identified among the lavas of Mawenzi and other periods of parasitic activity certainly occur. The cones are mostly arranged in well-defined belts corresponding in some cases clearly to important regional tectonic or volcano-tectonic lines.

The Saddle zone. This zone comprises eleven eruptive centres arranged in two prominent WNW.-ESE. lines between the main centres of Kibo and Mawenzi. The northern line is, in part, pre-Caldera Rim group in age and includes ankaramites, basalts and trachyandesites. The southern line entirely post-dates the Caldera Rim group, and includes ankaramites and basalts. An isolated centre between the lines has erupted basalt and nepheline rhomb porphyry.

The Rombo zone. This zone appears to continue the southern Saddle line to the south-east of Mawenzi. Comprising more than a hundred cones it is the densest group of parasitic cones on the mountain. The upper part consists of lava and scoria cones, entirely ankaramitic in nature The part within and below the forest, consists mainly of ash cones with ankaramitic and olivine basaltic affinities. All this activity is young in age. Lake Chala lies isolated at the south-eastern extremity of the Rombo Zone. It occupies a large caldera, some 300 feet deep, and is surrounded by a shallow rim of agglomerate and tuff. The walls expose Mawenzi-derived lavas. It is possible that the large spread of water-deposited calcareous tuffaceous grits in this south-east corner of the sheet was derived from the Chala centre.

Kilema zone. This zone is a conspicuous raised area emanating from a point south of the Saddle at 9,000 feet and running in the general direction of the Pare Mountains. Some twenty dissected basaltic scoriaceous sones overlie and partly obscure a thick older series of basaltic to ultramafic lavas which apparently form the bulk of the raised area. These older rocks appear to be overlain by

lavas of the Mawenzi group on their eastern margin, and may prove to correlate with the Neumann Tower group, or to be even older.

Kibongoto zone. Below 7,000 feet on the southern flanks of Shira is an area in which a number of very old and eroded cones occur, but their relationship to the Shira lavas is unknown.

(2) Regional Structural Features

The Kilimanjaro massif appears to be situated at the intersection of two major tectonic lines: the NNW.-SSE. faulted Pangani Trough, situated between the Pare Mountains and the Lelatema Mountains and an E.-W. trending zone apparently extending from the Gregory Rift Valley 80 miles or so to the west. Most of the faulting pre-dates the volcanic activity and whithin the bounds of this sheet the structures are buried.

(3) Volcano-Tectonic Features

The alignment of calderas, volcanic vents, parasitic cones, and dyke swarms is evident from the map and these lines clearly have some form of structural control, though whether this is of purely volcanic origin or has regional significance is not certain.

(4) Economic Geology

Meerschaum is mined at Sinya, north-west of Kilimanjaro. The deposits are found in lacustrine limestones, associated with green sepiolitic clays, which extend across the border into Kenya along the south-eastern margin of Lake Amboseli. Meerschaum is made into pipes at a modern, well-equipped factory in Arusha. Larger pieces are used for block-meerschaum pipes, smaller pieces for inserts in pipe bowls and the fine material is reconstituted into blocks (called "arcon" to distinguish it from natural block-meerschaum) from which pipes, with the excellent smoking characteristics of natural meerschaum, are made.

Stones for building and road construction are in fairly plentiful supply but there is a shortage of suitable sand for building purposes near Moshi and in the areas occupied by colcanic rocks. Building sand is quarried in the Pangani alluvium near Kikafu ya Chini.

Water Supply. Kilimanjaro is situated in the centre of an extensive arid area of East Africa where the plains normally receive less than 20 inches of rain per annum. Precipitation increases on the mountain itself. The north and east sides of the mountain receive the short rains (November-early December) while the long rains (April-May) fall mainly on the south side. The highest rainfall (over 60 inches per annum) occurs on the southern slopes of the mountain centred on Machame and Marangu. On the north and north-east side of the mountain, rainfall is lower, usually between 30 and 40 inches.

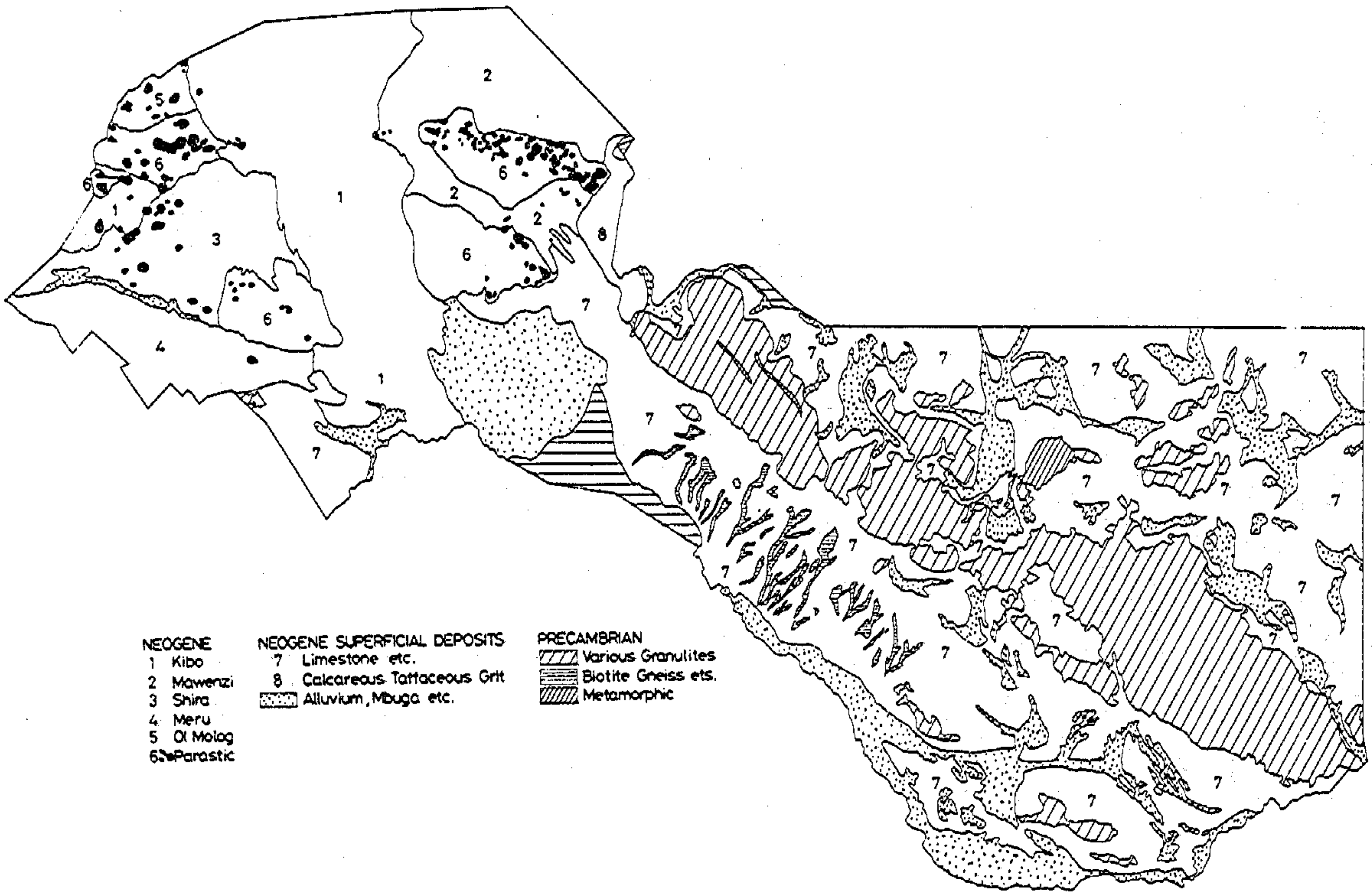
Permanent surface water is found mainly on the southern slopes of the mountain where all the larger streams flow perennially. With the exception of the Karanga Weru Weru and the Rau, all these usually dry up before reaching the plains in the dry season. On the north and east sides of the mountain, permanent surface water is confined to the forest belt on the lower slopes and only the Lumwe stream flows below the forest line in the dry season. On the upper mountain slopes, surface water is found in pools only at a few places (e.g. near Peters Hut) in the dry season.

Although much of the rain falling on the mountain is dissipated in surface run-off, much water is readily absorbed by the pervious volcanic formations and tends to migrate to the botton of the volcanic pile, held up in some places by impervious lava flows to emerge as small springs which occur frequently in the forest belt. Most of these springs are utilised to feed pipe lines which serve the population on the lower slopes of the mountain.

Large springs occur at the foot of the mountain near Moshi and at Miwaleni on the south side. On the south-east, east and north sides of the mountain, all the large springs (Kitovu, Taveta, Ziwani and Litokitok) are located in Kenya.

Over sixty boreholes have been drilled for water in the Kilimanjaro-Moshi area. In general, boreholes drilled in volcanic formations around the foot of Kilimanjaro have been successful. Large quantities of ground water can be reached within 400 feet of the surface. Boreholes drilled near Moshi and Sanya Juu have frequently given yeields of over 2,000 gallons per hour; some have given much higher yields. In West Kilimanjaro (Engare Nairobi) area, boreholes have been less successful. On the slopes of Kilimanjaro several successful boreholes have been drilled on the southern side, in particular near Marangu, Uru and Machame where surface water is abundant and perched ground water horizons are struck at relatively shallow depth. Many other boreholes have proved dry or ground water from levels near the surface has been lost with continued drilling in attempts to increase water yield. On the eastern slopes of Kilimanjaro, only one borehole, at Keni, has been successful; five other boreholes drilled in Mkuu and Mashati areas were dry.

GEOLOGY (Fig.-12)



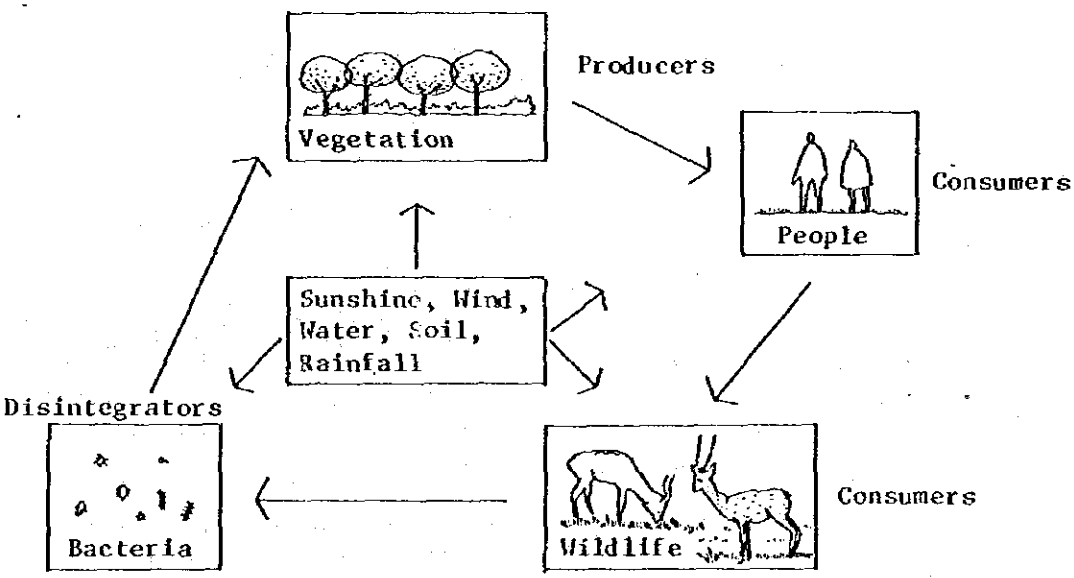
3. FOREST PLAN

3.1 Problem Identification

(1) Forests

The purpose of this section is to observe the present state of the natural environment of the Kilimanjaro Region from an ecological viewpoint, analyze various problems in this regard and the reasons for them, and serve as material that can be consulted for the purpose of establishing an ecologically balanced natural environmental system.

The following is a diagram of the ecological system of the region. (Fig.-13)



The factors which upset the ecological balance or cause damage to the environment are treated separately below according to whether they relate to humans, natural phenomena, or wildlife.

(i) Factors Relating to Humans

- Recession of vegetation owing to repeated slash-and-burn cultivation and mountain fires
- Decline of productivity of soil owing to overintensive agricultural use
- Reduction of ground cover by overgrazing and consequent washing away of fertile soil
- Poor growth of vegetation owing to chopping off of tree branches and mowing of grass

- Impairment of the temperature adjustment function of greenery by reduction of the rate of green ground coverage, with a consequent decline in rainfall (Such change in climatic conditions is observable only over the long run.)

(ii) Factors Relating to Natural Phenomenon

- Destruction of ground cover on steep slopes and washing away of topsoil
- Washing away of ground of marshes with steep slope and erosion of river beds
- Temporary interruption of road traffic owing to flooding of rivers after localized torrential showers
- Drought damage to farmland
- Crop damage due to strong winds and sandstorms

(iii) Factors Relating to Wildlife

- Knocking down of trees in forests (including forest reserve areas) by elephants and buffalo
- Damage to saplings and young trees by monkeys and other animals
- Recession of ground cover and damage to crops owing to overproliferation of wildlife

Besides these problems relating to the ecological system, there is the problem of insufficient production of timber in the Kilimanjaro Region, which necessitates dependence on other regions in order to meet local demand. Because of this fact, it will be necessary to expand the forest areas of the region, particularly on mountain slopes.

Of the above factors, these relating to wildlife or to natural phenomenon can be solved to a certain extent by natural selection and human control. The biggest problem is that of the influence of human activities on the natural environment. Hence the need to do all that is possible to ensure that the ecological balance is maintained, particularly through provision of forests and other greenery.

Let us now consider the need for (1) natural environment conservation forests and (2) production forests.

3.2 The Need for Forests

(1) Natural Environment Conservation Forests

Forests, particularly in areas with severe natural conditions such as the Kilimanjaro Region, can help to conserve the natural environment in many ways, including those listed below and by promoting the stability and progression of other vegetation:

1) Water resource function.......ensuring a stable supply of water

2) Prevention of washing away of earth.....stabilization of river beds and banks

3) Prevention of landslides and loss of topsoil

4) Prevention of flood damage by temporarily holding back the rainwater

5) Windbreaking

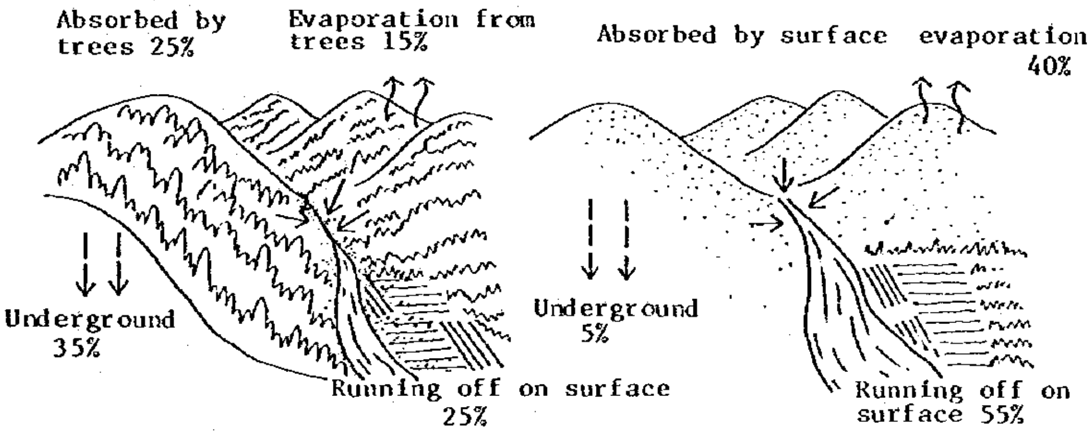
6) Drought prevention through reduction of evaporation

7) Temperature adjustment through provision of shade

8) Improvement of soil quality through the rotting of fallen twings and leaves and by increasing the number of bacteria and microorganisms in the soil

These damage prevention, environmental control, and soil improvement functions of forests will be very important over the long run in the Kilimanjaro Region in view of the fact that it is confronted with many serious problems of this nature.

Movement of Rainwater in the Cases of Afforested Mountains and Bare Mountains (Fig.-14)



Afforested mountains Bare mountains

Breakdown of Present Forest Area in the Region by District

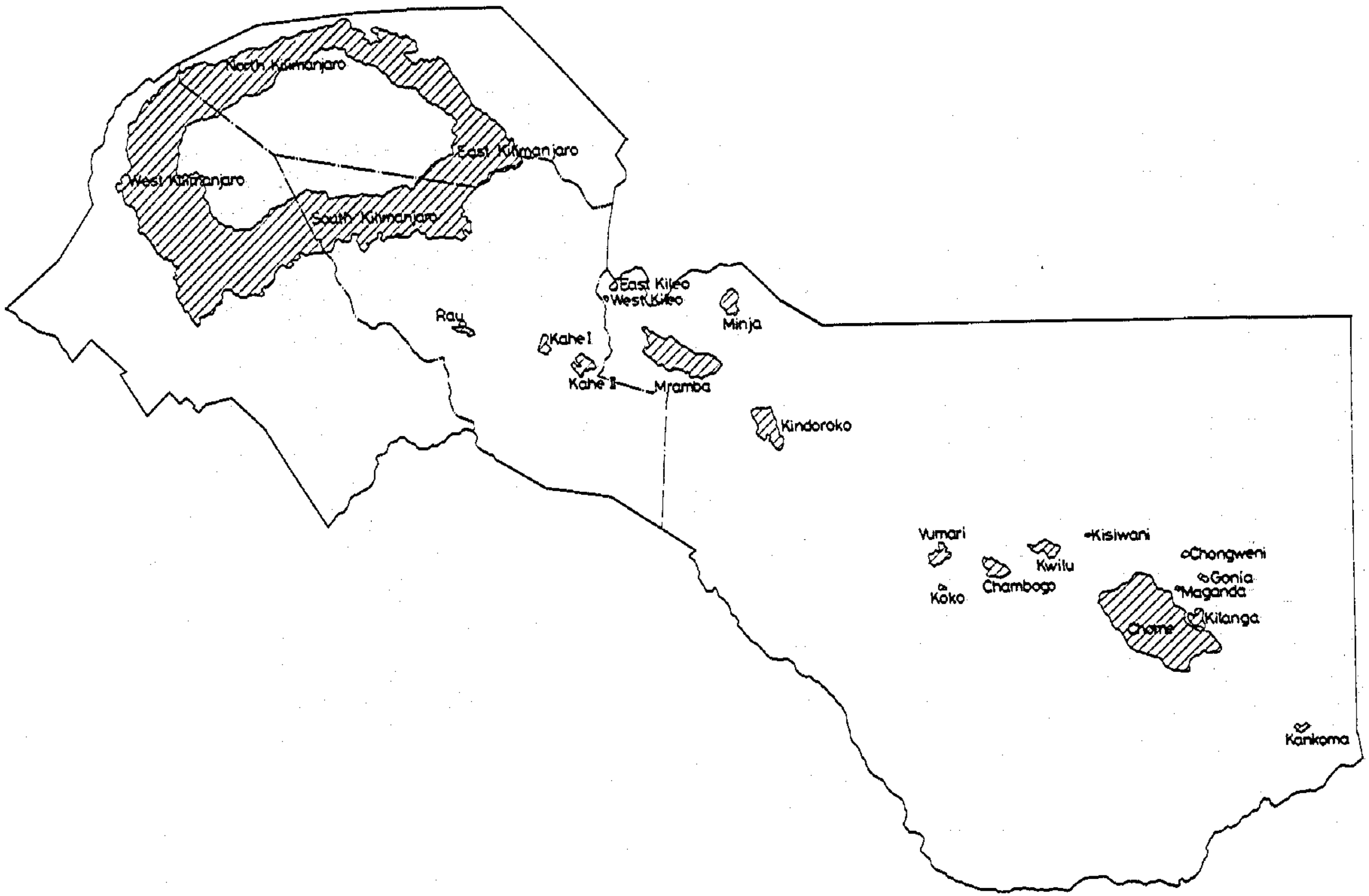
District	Area (ha)	%
Hai	529.0	41.1
Moshi	217.2	16.9
Rombo	320.0	24.9
Pare	220.0	17.1
Total	1,286.2	100.0

The total forest area in the region at present accounts for only 9.7% of the total area of the region.

(2) *Production Forests*

It is important that a clear distinction be made between natural environment conservation forests and production forests. Although the latter also to a certain extent play an environmental conservation role, that is not their main purpose. Accordingly, they can be exploited for a maximum harvest by rotation felling from a purely economic point of view.

FOREST RESERVE (Fig.-15)



The following is an inventory of the production forests that are presently to be found in the Kilimanjaro Region:

Rau forest (Moshi District)	620 ha
Kahe forests I and II (Moshi District)	1,277 ha
Kilimanjaro forest (Hai, Moshi, and Rombo)	185,896 ha
Chambogo forest (Pare District)	5,467 ha
Chome Forest (Pare District)	14,283 ha
Total	207,543 ha

Except for the Rau forest and the Kahe forests, however, they all have an additional natural environment conservation function.

Production from these forests has been fairly steady for the last several years:

1971	16,900 m^3
1972	19,500
1973	30,700
1974	15,400
1975	20,400
1976	30,000 (estimated)

The main consumers have been as follows:

	1972	1973	1974
1. Majengo Timbers	351 m^3	1,911 m^3	339 m^3
2. Kilimanjaro Timbers	528 "	5,044 "	5,943 "
3. Kilimanjaro Saw Mill	1,648 "	3,423 "	4,576 "
4. Sambarani Saw Mill	-	273 "	416 "
5. New Kilimanjaro	186 "	302 "	690 "
6. C. Singh	660 "	1,923 "	5,686 "
7. Moshi Plywood	-	3,567 "	2,368 "
Totals	3,373 m^3	16,443 m^3	20,018 m^3

The wood produced has been used as follows:

	Housing materials(m^3)	Fuel wood and charcoal (m^3)	Totals (m^3)
1971	8,900	58,963	67,863
1972	14,045	2,045	16,090
1973	13,813	3,674	17,487
1974	7,715	16,075	23,790
1975	12,962	20,133	33,095

Demand for forest products has been steadily growing within the region, and since 1974 it has been necessary to bring in products from other regions in order to fill the gap between demand and regional production.

	Production (m^3)	Total demand (m^3)	Shortage(-) or surplus (+)
1971	16,900	67,863	- 50,963
1972	19,500	16,090	+ 3,410
1973	30,700	17,487	+ 13,213
1974	15,400	23,790	- 8,390
1975	20,400	33,095	- 12,695

Future Demand for Forest Products and the Need for More Production Forest Acreage

The proposed forest production target for 1995 is regional self-sufficiency. The forestry industry differs from other industries in that a long period of time is required in order to achieve an increase in production owing to the fact that the growth of trees is slow. Achievement of this long-term goal of production self-sufficiency, moreover, will depend on improvement of production technology and facilities on a long-range planning basis.

In 1975 per-capital consumption of forest products was as follows:

(A)	Housing materials	0.015 m^3
(B)	Fuel wood and charcoal	0.023 m^3
	Total	0.038 m^3

There should be considerable change in the demand for wood as population increases, living standards rise, and income increases. The demand for housing materials will be affected by the supply of concrete blocks, which has begun only recently, and the demand for fuel wood and charcoal, too, can be expected to decline appreciably with increased use of oil, gas, and other forms of energy.

Although it is therefore difficult to say just what the per-capita level of demand for wood will be, the figure of 0.12 m^3, or three times the 1975 level, has been assumed for 1995. This comes to 174,720 m^3 with a population of 1,456,000.

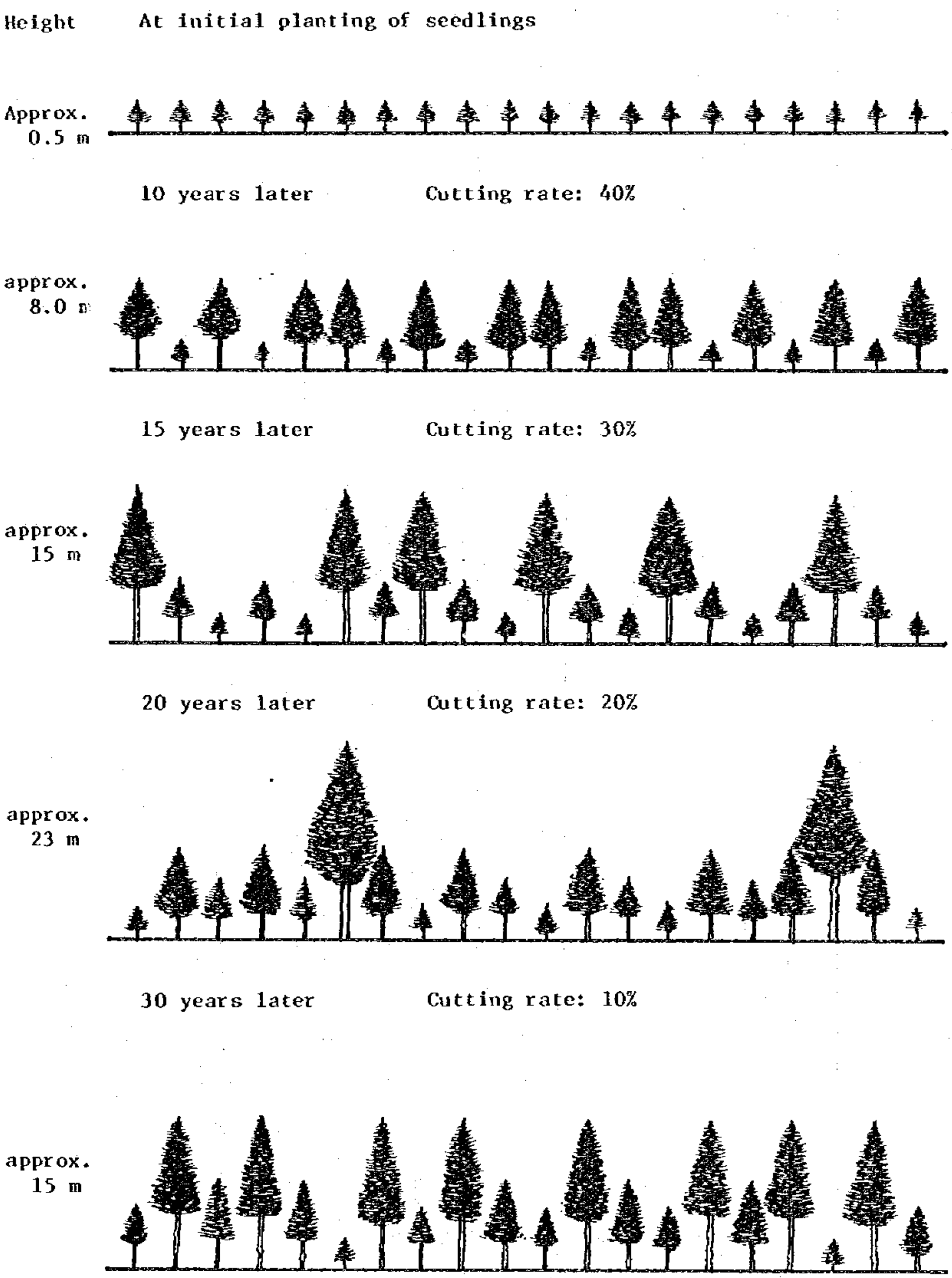
The annual production of existing commercial exploitation forests will be maintained at the present level of 30,000 m^3 since they are for the most part rather small in scale and therefore will not be able to increase their production very rapidly. As for the Mt. Kilimanjaro Forest Reserve, which accounts for a considerable portion of present production, its commercial exploitation areas should not be extended in view of the importance of its natural environment conservation role, including its water resource function.

In order, therefore, to make it possible to supply the 144,720 m^3 a year difference between the demand forseen for 1995 and the level of production of these forests, it will be necessary to plan for new forests for commercial exploitation.

Since average annual production from 1 km^2 of such forests is about 2,000 m^3 when 20-year-old trees are felled, this supply gap can be filled by planning for approximately 70 km^2 of new commercial exploitation forests.

The following will be the yields at each cutting:

Tree Growth Profiles of Production Forests (Fig.-16)

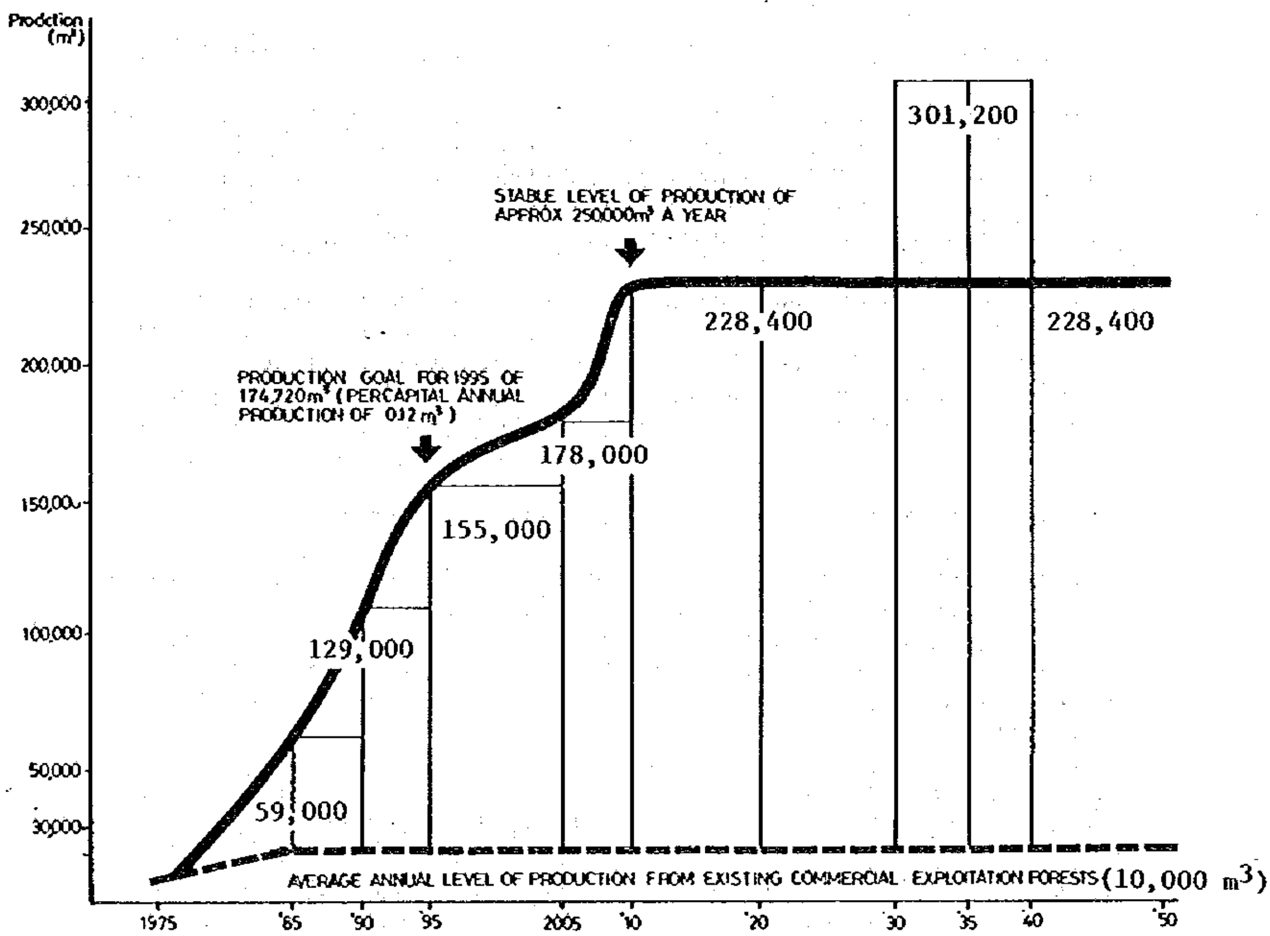


Cutting Limits and Production Levels for 70 km^2 of New Forests for Commercial Exploitation (Table-2)

	1985	1990	1995	2005	2010	2020	2030	2035	2040
Cutting rate (%)	40	30	20	10	30	30	20	20	
Cutting area (km^2)	28.0	21.0	14.0	7.0	21.0	21.0	14.0	14.0	
Average annual cutting area (km^2)	5.6	4.2	1.4	1.4	2.1	2.1	2.8	2.8	
Tree age	10-15	15-20	20-30	30-35	25-35	25-35	25-35	25-35	
Average annual production (m^3)	49,000	119,000	145,600	168,000	218,400	218,400	291,200	291,200	
Average annual production (m^3) from existing commercial exploitation forests (*)	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	
Average total annual	68,000	129,000	155,600	178,000	228,400	228,400	301,200	301,200	

* : Production levels foreseen for Rau and Kahe.

HOW THE LEVEL OF PRODUCTION WILL CHANGE



3.3 Potential Analysis

This section deals with finding 1) potential areas requiring afforestation from the standpoint of natural environment conservation and 2) potential areas for production forests, as discussed in 3.1 The Need for Forest.

(1) Finding potential areas requiring afforestation from the standpoint of natural environment conservation

The following items are to be analyzed:

Areas performing water resource functions

Areas where the possibility of landslides exists

Areas where the possibility washing away of soil exists

Areas where the possibility of flood damage exists

Areas where the possibility of drought damage exists

Based on the results of the above analyses, each area will be classified and the necessary protective measures and land utilization regulations will be carried out.

The regulations on land utilization are to cover the following:

Forest reserve areas: The same regulations as currently in force in other Forest Reserves shall be carried out. The regulations will include prohibition of tree cutting, stock farming, harvesting of undergrass, chopping off of tree branches, construction of houses, cultivation of land, and collection of soil and gravel.

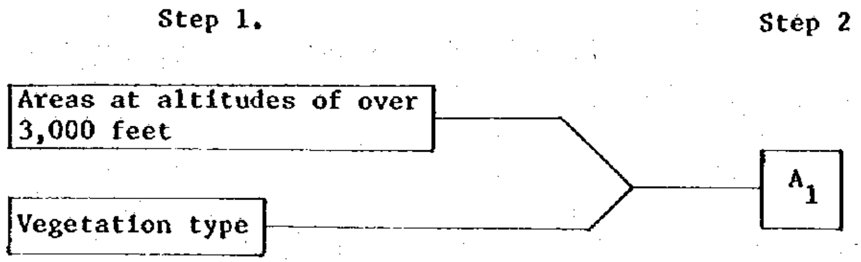
Natural environment control areas: Less severe regulations than those in other Forest Reserves shall be carried out. The regulations will include prohibition of tree cutting, high-density stock farming, large-scale topographical changes, and collection of soil and gravel. The areas will be afforested over a long period of time.

o Analysis of areas performing water resource functions

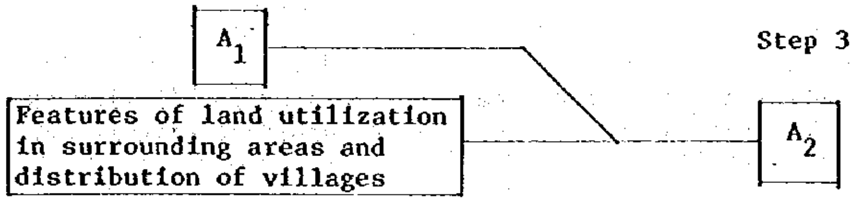
Areas performing water resource functions differ mainly according to the amount of rainfall and the type of vegetation covering the area. Since water plays an important role as the prerequisite of human life and industry, classification of the areas performing water resource functions is made based on the features of land utilization around the area.

Step 1. Establishment of target areas at altitudes of over 3,000 feet where rainfall is relatively abundant.

Step 2. Sampling out of areas A1 from the areas in Step 1, where the vegetation type is forest, woodland, or thicket.



Step 3. Areas A1 are classified according to their degree of importance for the land utilization of surrounding areas and distribution density of villages.



Areas classified as A2 are divided into two sub-classes.

Sub-class 1. The most important areas performing water resource functions.

These areas are to be conserved at present and in the future as the prerequisite of life and industry. In these areas, except present Forest Reserves, category a land utilization regulations will apply.

Sub-class 2. Areas with some water resource functions. Category B land utilization regulations will apply in these areas

DISTRICTS / CLASSIFICATIONS	HAI	MOSHI	ROMBO	PARE	TOTAL
1	444.25	181.25	303.25	406.5	1,335.25
2	69.0	-	-	568.0	637.0
TOTALS	513.25	181.25	303.25	974.50	1,972.25 (km^2)

o Analysis of areas where the possibility of landslides exists.

The degree of danger of landslides or erosion varies according to the topographical gradient and the types of vegetation covering the surface. Analysis is to be made as follows:

Step 1. Areas are classified according to topographical gradient and vegetation types.

SLOPE / TYPE OF VEGETATION	Over 30°	15-30°	Under 15°
SCRUB	I	II	III
SCATTERED TREES	II	II	III
SCATTERED TREES and SCRUB	III	III	III

Step 2. Potential landslide areas are found by considering the areas classified in Step11 in combination with the amount of rainfall

ANNUAL RAINFALL / CLASSIFICATION IN STEP 1	Over 1,000 mm	700 mm - 1000 mm	500 mm - 700 mm
I	1	1	2
II	1	2	3
III	2	3	3

Sub-class 1. Areas where a strong possibility of landslides exists.

Afforestation and other preventive measures are required immediately from the standpoint of natural environment conservation. Category A land utilization regulations are to be applied.

Sub-class 2. Areas where a possibility of landslides exists.

Afforestation over a long period of time is necessary. Category B land utilization regulations are to be applied.

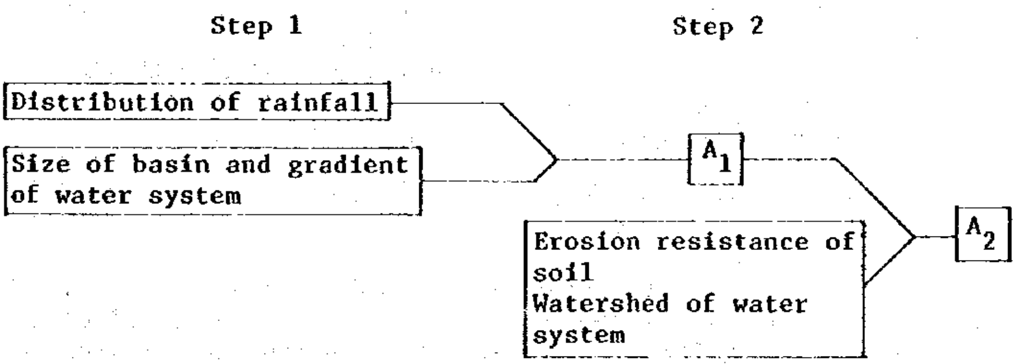
DISTRICT / CLASSIFICATION	HAI	MOSHI	ROMBO	PARE	TOTALS
1	-	-	-	29.25	29.25
2	58.25	138.25	-	70.25	266.75
TOTALS	58.25	138.25	-	99.50	296.00 (km^2)

- Analysis of areas where the possibility of washing away of soil exists
- Analysis of areas where the possibility of flood damage exists.

The degree of danger of washing away of soil and flood damage varies according to the relationship between the features of the water system, the amount of rainfall, and erosion resistance of the soil in the area of each water system. The extent of flood damage also depends on the features of land utilization and distribution of roads, railroads, etc.

Step 1. Potential areas are to be found by examining the distribution of rainfall, size of the basin, and gradient of the water system.

Step 2. Areas in danger of washing away of soil are to be found among the A1 areas determined in Step 1., by considering the erosion resistance of the soil and the watershed of the water system.



A2 areas found in Step 2 are to be sub-classified as follows:

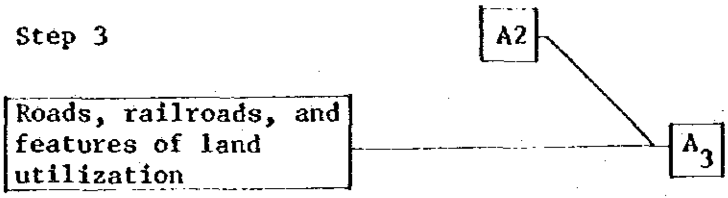
Sub-class 1. Areas where a possibility of washing away of soil or loss of topsoil exists.

Afforestation over a long period of time is necessary in such areas to consolidate the prerequisites of life and industry. Category B land utilization regulations are to be applied.

DISTRICT / CLASSIFICATION	HAI	MOSHI	ROMBO	PARE	TOTALS (km^2)
1	119.0	234.0	160.0	26.0	539.0
2	LITTLE	QUITE A LOT	QUITE A LOT	LITTLE	-

Step 3. Areas where a strong possibility of flood damage exists are to be found among A2 areas by considering the distribution of roads and the features of land utilization of the surrounding areas.

Step 3



A3 areas found in Step 3 are sub-classified as follows:

Sub-class 1. Areas where a strong possibility of flood damage exists.

Investigation of flood damage conditions and afforestation requirements are necessary from the standpoint of life environment conservation. Category A land utilization regulations are to be applied.

Sub-class 2. Areas where a possibility of flood damage exists.

These areas require the same investigations of flood damage conditions and afforestation as sub-class 1 areas. Category B land utilization regulations are to be applied.

- Analysis of areas where a possibility of drought damage exists.

Though the degree of danger of drought damage depends mainly on the crop types and the amount of rainfall, it is also affected by the size of agricultural land and the surrounding environment, especially the type of veg tation. Analysis here is mainly aimed at large-scale plantations.

Step 1.

TYPE OF VEGITATION AROUND THE PLANTATION	ANNUAL RAIN FALL UNDER 500mm	500mm - 700mm	OVER 700mm
SCRUB. SCATERED TREES	1	2	3
SCATTERED TREES AND SCRUB	2	2	3
THICKETS WOODLANDS FORESTS	3	3	3

Furthermore, water retention capacity, desiccation of soil, and types of currently cultivated crops must be taken into consideration.

Sub-class 1. Areas where a strong possibility of drought damage exists.

In these areas it is necessary to carry out afforestation inside and around plantations in order to provide shade.

Sub-class 2. Areas where a possibility of drought damage exists.

These areas also require afforestation inside and around plantations to provide shade.

DISTRICT / CLASSIFICATION	HAI	MOSHI	ROMBO	PARE	TOTALS (km^2)
1	58.36	55.12	-	32.73	146.21
	QUITE A LOT	QUITE A LOT	LITTLE	LITTLE	-

(2) Finding potential areas for production forests

The potential for production forests is determined by the natural conditions (terrain gradient, productivity of soil, and amount of rainfall) and social conditions of the area (agricultural land utilization, distribution of villages, accessibility by road, etc., and irrigation including water and power supply). Analysis is made as follows:

Step 1. All areas with no forestry potential are excluded. As production forests are required to be productive, areas with an annual rainfall of less than 500 mm are excluded, since such areas are not suitable for good growth of any vegitation. Also excluded are village areas, areas with a population density of more than $200/km^2$, forests, Forest Reserves, swamps, lakes, plantation areas, and Game Reserves.

Sep 2. Areas classified in Step 1 are classified according to the forestry productivity determined by terrain gradient and soil productivity.

SOIL FERTILITY / SLOPE	VERY GOOD	GOOD	FAIR	POOR
UNDER 15°		I	II	III
15° - 30°	I	II	III	III
OVER 30°	II	III	III	III

Step 3. Areas classified in Step 2 are to be considered in combination with the distribution of rainfall and divided into sub-classes A - E.

Step 3

CLASSIFICATION IN STEP-1	ANNUAL RAINFALL OVER 1000mm	700mm - 1,000mm	500mm - 700mm
I	A	B	C
II	B	B	C
III	D	D	E

Sub-class A. Areas with the highest forestry potential and at the same time the most suitable areas for agriculture.

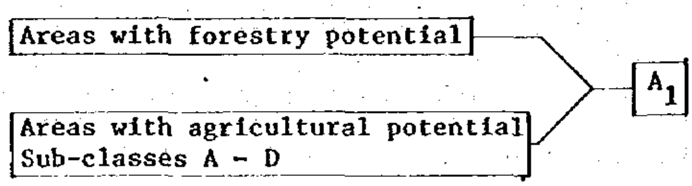
Sub-class B. Areas with high forestry potential.

Sub-class C. Areas with some forestry potential.

Sub-class D. Areas with low forestry potential.

Sub-class E. Areas with almost no forestry potential.

Step.4 The potential for agricultural use of the areas sampled out in Step 3 is taken into consideration. Areas with potential for agricultural use A - D (areas with high to low potentials for agricultural use) are excluded from potential areas for forestry.



Step 5. Areas B and C sub-classified in Step 3 are considered in combination with conditions such as accessibility by road and irrigation.

CLASSIFICATION IN STEP-3	IRRIGATION AVAILABILITY AND ACCESSIBILITY GOOD	FAIR
B	1	2
C	3	4

Sub-class 1. Areas with the highest forestry potential.

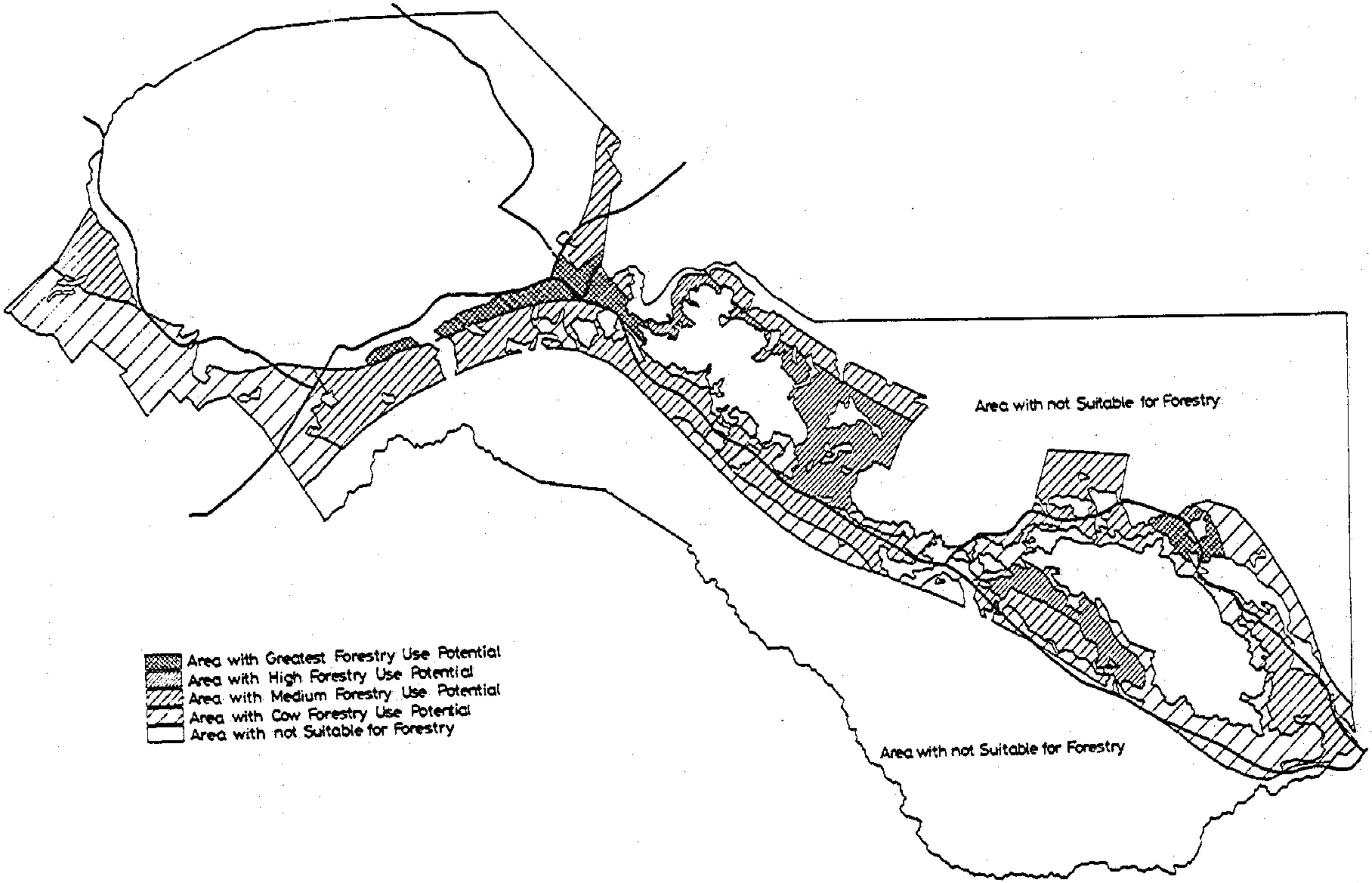
Sub-class 2. Areas with high forestry potential.

Sub-class 3. Areas with some forestry potential.

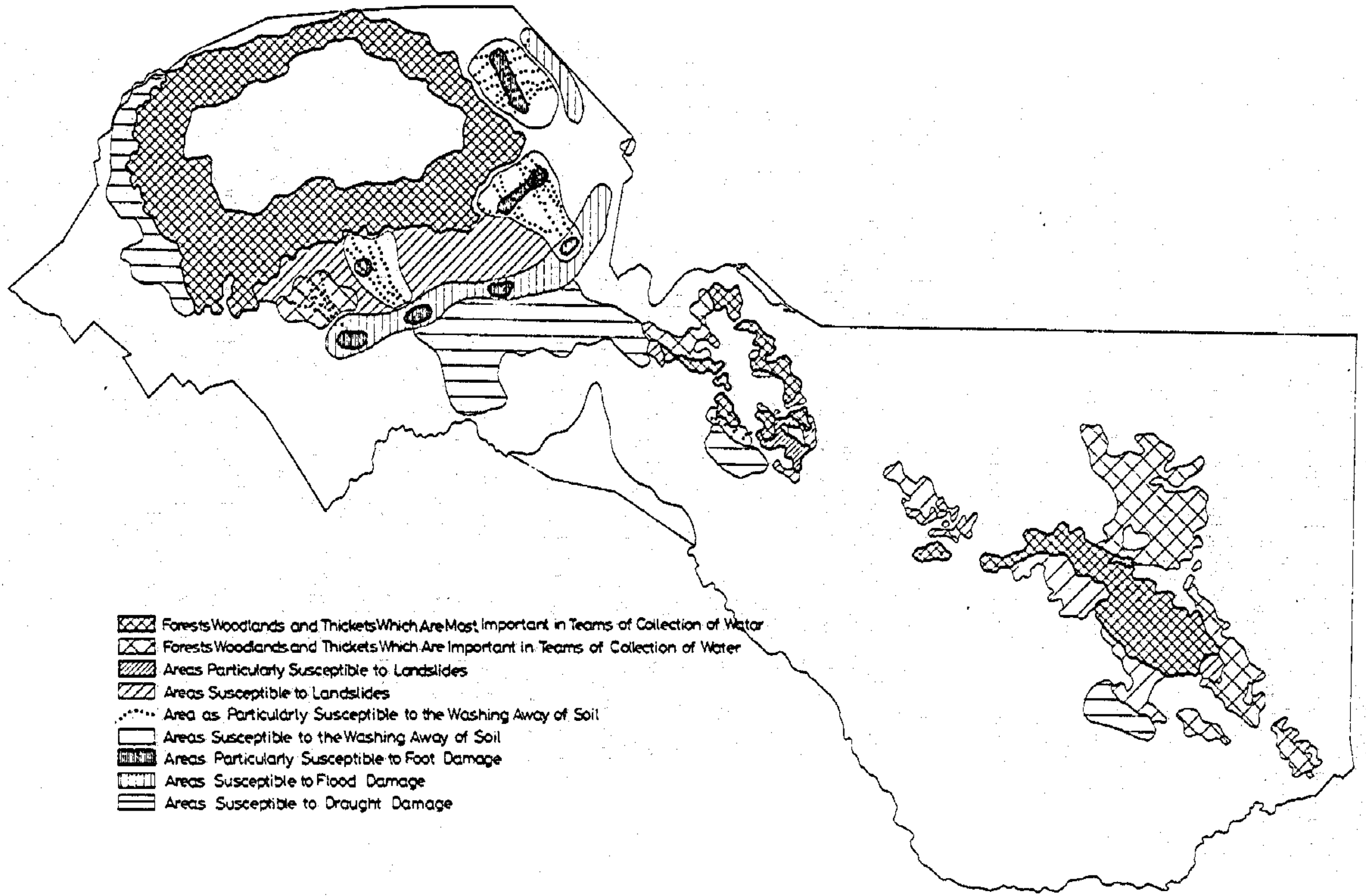
Sub-class 4. Areas with low forestry potential requiring irrigation.

DISCTRICT / CLASSIFICATION	HAI	MOSHI	ROMBO	PARE	TOTALS (km^2)
1	9.4	90.6	-	68.7	168.7
2	-	25.0	31.3	362.5	418.8
3	250.0	87.5	-	703.1	1,040.6
4	462.5	18.7	-	650.0	1,131.2

FORESTRY SUITABILITY (Fig.-18)



CONSERVATION VALUE (Fig.-19)



3.4 Project Finding

Areas where afforestation or other countermeasures are necessary for conservation of the natural environment, found through potential analysis, are ranked by importance.

Below the projects are examined by year.

(1) Projects to be carried out by 1985

The objectives of the projects are areas where immediate measures must be taken for conservation of the natural environment and the natural balance is already disturbed. These projects cover the following:

- Most important areas performing water resource functions.

  These are Forest Reserve areas on the slopes of Mt. Kilimanjaro and areas in the South Pare Mountains at altitudes of over 4,000 feet. In case of the South Pare Mountains, some areas are not designated as Forest Reserves and immediate designation of 135.0km^2 as Forest Reserve area is necessary to prevent future exploitation problems caused by population increases.

- Areas where a strong possibility of landslides exists.

  Included in this category are mainly the steep slopes on the southern side of the North Pare Mountains covering an area of approx. 30.0km2. These areas require immediate afforestation to stabilize the land.

- Areas where a strong possibility of washing away of soil exists.

  Included in this category are mainly the steeply sloped rivers of about 25.7km in total length on the southern and eastern sides of Mt. Kilimanjar. A 50 m wide afforestation belt is to be established to stabilize the river banks and to prevent washing away of soil in these areas.

HAI	MOSHI	ROMBO	PARE	TOTALS
5.95	11.70	8.00	-	25.65 (km^2)

- Areas where a strong possibility of flood damage exists.

  Flood damage is concentrated in the areas along the national highway on the southern side of Mt. Kilimanjaro, where rainfall is abundant and the slopes of river beds change. Intensive afforestation of an area of 12.0 km2 and construction of erosion control guards is necessary to minimize road destruction caused by localized heavy rains, since the highway is the traffic artery, i.e., the most important means of communication in the region. Afforestation is aimed mainly at stabilizing the soil with vegitation coverage and increasing the water retention capacity of the land.

To start with, pioneer vegitation capable of growing rapidly on poor soil is to be selected. Initially this vegitation will not fully perform the aimed at functions, but with passing time, a transition of vegitation gradually takes place until finally the climax vegitation suited to the area is formed. It is important to maintain and control the afforested areas until the climax végitation is formed after proper transition.

The afforested areas are to be designated Forest Reserves to minimize the influence of humans and livestock, and must be conserved over a long period of time as the basis of a "greenland system" in the region.

- Development of production forests

Since, of the existing production forests in the region, the "Rau forest" and the "Kahe forests I and II," all three of which are located in the Moshi District, have high productivity based on good economic conditions of location, they will be further developed as production forests. As for the "Kilimanjaro forest" (Hai, Moshi and Rombo districts) the "Chambogo forest" (Pare District), and the "Chome forest" (Pare District), they will be developed as conservation forests since they have steep slopes and otherwise poor topographical conditions that would present many problems if they were to be developed as production forests.
An extensive production forest of 8,000 ha in area is to be developed in the lowland of the Moshi District among the areas (168.7km2) classified in Sub-class 1 in the potential analysis. Although there is another area of 68.7km2 classified in Sub-class 1, on the eastern side of the South Pare Mountains, development of production forests on the southern slopes of Mt. Kilimanjaro is preferable due to the following reasons:

- The forest performs the function of life environment conservation for the densely populated highland areas.
- The cost of transportation is low as the timber mills and places of consumption are located in close proximity.
- The land utilization zoning of the footland of Mt. Kilimanjaro will be made clearer.

With the increasing demand for timber, the area on the eastern side of the South Pare Mountains can be developed as a production forest in the future.

(2) Projects to be carried out after 1985

These are long-term projects for natural environment conservation or life environment conservation.

The main projects cover afforestation of areas where the balance of the natural environment might be disturbed and other measures necessary to improve the life environment.

° Preparation of areas surrounding forests performing water resource functions.

An 800 m wide mantle is planted along the edge of the forest for protection, since such areas are easily affected by human life. This is especially necessary for the forest zone of Mt. Kilimanjaro.

° Afforestation along the water systems

Extensive greenery areas are at present the forest zones of Mr. Kilimanjaro and the Pare Mountains at altitudes of above 4,000 feet. From these large-scale and intensive forests, 50 m wide greenbelt zones are to be extended along the rivers as the long-term afforestation master plan of the region. These greenbelt zones will form the backbone of the future "green network" of the region.

HAI	MOSHI	ROMBO	PARE	TOTALS (km^2)
6.6	54.6	-	633.3	694.5

° Afforestation along roads

The aims are the same as stated for afforestation along the water systems. However, this also involves improving the roadside views and creating a symbol for the region by planting a uniform type of tree, which are highly effective means to increase tourism.

HAI	MOSHI	ROMBO	PARE	TOTALS (km^2)
1,4	0.9	0.4	4.0	6.9

° Afforestation inside and around plantations

Greenery areas of suitable sizes are to be developed for drought prevention and as windbreakers.

HAI	MOSHI	ROMBO	PARE	TAOTALS (km^2)
-	4.9	-	5.9	10.8

° Maintenance and cutting of trees in the production forests

The main operations during the periods 1985-1995 will be chopping off tree branches and mowing the undergrass.

3.5 Project Plans

This section deals with details, such as scope, scale and costs of each project as per (3) Project Finding, to be carried out by 1985. The following four projects are planned:

Project 1. Afforestation project for the steep slopes of the southern side of the North Pare Mountains to prevent landslides.

The total area to be afforested is approx. 50.0 km2.
This project is to be planned and let by the district forest officer. During the 10-year period of the project 5.0 km2 ha are to be afforested yearly. Enlisting the voluntary services of local inhabitants for the works should be taken under consideration.

Yearly project expenditures

° Personnel expenditures		380,000 shil
Assistant forester	2 X 18,000 shil =	36,000 shil
Forest workers	20 X 7,200 shil =	144,000 shil
Temporary forest workers or voluntary workers	20,000 X 10 shil =	200,000 shil
° Cost of the survey made by the assistant forester		10,000 shil
° Cost of seedlings		75,000 shil
Cost of work tools such as hoes, sickles, saws, etc.		25,000 shil
° Administrative expenditures Cost of office supplies, transportation, and communication.		10,000 shil

ANNUAL DEVELOPMENT COST (1000 sh)

Development Cost	310
Recurrent Cost	190
TOTAL	500

Project 2. Afforestation project along the steeply sloped rivers on the southern and eastern sides of Mt. Kilimanjaro to prevent washing away of soil and to stabilize the river banks. The total area to be afforested is approx. 26.0 km2. This project is to be planned and led by the district forest officers of each project area. During the 10-year period of the project approx. 2.6km2 are afforested yearly. Enlisting the voluntary services of local inhabitants for the works should be taken under consideration.

Yearly project expenditures

° Personnel expenditures		208,000 shil
Assistant forester	2 X 18,000 shil =	36,000 shil
Forest workers	10 X 7,200 shil =	72,000 shil
Temporary forest workers or voluntary workers	10,000 X 10 shil =	100,000 shil
° Cost of survey made by the assistant forester		5,000 shil
° Cost of seedlings		40,000 shil
° Cost of work tools such as hoes, sickles, saws, etc.		13,000 shil
° Administrative expenditures Cost of office supplies, transportation, nnd communication.		5,000 shil

ANNUAL DEVELOPMENT COST

	(1000 sh)
Development Cost	158
Recurrent Cost	113
TOTAL	271

Project 3. Afforestation project for the areas along the national highway on the southern side of Mt. Kilimanjaro to prevent flood damages. The total area to be afforested is approx. 12.0km2. This project is to be planned and led by the regional forest officer in cooperation with the district forest officers. During the 10-year period of the project approx. 1.2 km2 are to be afforested yearly.

Work will be started first in areas where flood damage is more serious.

Yearly project expenditures

- Personnel expenditures — 284,000 shil

Forest project officer	1 X 108,000 shil	=	108,000 shil
Foresters	1 X 54,000 shil	=	54,000 shil
Assistant foresters	2 X 7,200 shil	=	36,000 shil
Forest workers	5 X 18,000 shil	=	36,000 shil
Temporary forest workers	5,000 X 10 shil	=	50,000 shil

- Cost of surveys made by the regional forest officer
  district forest officer
  forest project officer 5,000 shil

- Cost of seedlings — 20,000 shil

- Cost of work tools such as hoes, sickles, saws, etc. — 7,000 shil

- Administrative expenditures — 5,000 shil
  Cost of office supplies, transportation, and communication.

ANNUAL DEVELOPMENT COST (1000 sh)

Development Cost	82
Recurrent Cost	239
TOTAL	321

Project 4. Development of a production forest in the lowland of the Moshi District.

Area of production forest	70 km^2
Area of other grounds attached to the production forest	10 km^2
TOTAL	80 km^2

The final decision on this projects rests with the central government, but the local government will carry out the surveys, management, and operation of the project. Since this is a large-scale and long-term project, and the timber production will start after 20 years, thorough market research and careful examination of the types of trees to be planted is required before starting the project works.

The project is to be managed and operated according to the following organizational system.

Central Government

Local Government
(Kilimanjaro Rigion)

District Forest Officer

HAI District MOSHI District ROMBO District PARE District

FOREST OFFICER 1

FOREST PROJECT OFFICER 1

FORESTER 4

ASSISTANT FORESTER 8

FOREST CARD 30

FOREST WORKER 120

PART FOREST WORKER

The personnel needed to be stationed at the project areas are a forest project officer, a forest officer (marketing), and the subordinates shown in the chart.

Time schedules and costs of projects for each year during the 10-year project periods.

First year

The following projects are to be carried out in the first year. Related costs of each project are given below.

- Survey of project areas

  Surveys of water resources, soil analyses, land surveys, allocation of land for roads, studies on the possibility of landslides, etc. --- 100,000 shil.

- Drawing up of the master plan for land utilization of the project areas.

  Allocation of land for afforestation, forest stations, and tree nurseries --- 50,000 shil.

- Organization of forest stations

  Hiring of staff for forest stations and establishment of training facilities --- 10,000 shil.

- Examination of tree types for afforestation and experimental afforestation --- 50,000 shil.

- Construction of a 10 ha tree nursery --- 500,000 shil.
- Purchasing of 7,000,000 seedlings --- 420,000 shil.
- Personnel expenditures --- 220,000 shil.

Salaries for stationed staff (Persons)

Forest Officer (Marketing)		1
Forest Project Officer		1
Forester		4
Assistant Forester		8
Forest Gard		30
Forest Worker		120
Part Forest Worker	Total:	2,400

- Staff training --- 50,000 shil.
- Administrative expenses --- 50,000 shil.
- Purchasing of work tools such as hoes, sickles, saws, etc. --- 80,000 shil
- Purchasing of machinery --- 10,100,000 shil.

Bulldozers	(6 t)	5
Tractors	(4 t)	10
Trucks	(10 t)	4
Trucks	(4 t)	10
Jeeps		5
Landrovers		5
Stone crushers		1
Compressors		1

DEVELOPMENT COST OF THE FIRST YEAR (1000 sh)

Development Cost	11,230
Recurrent Cost	400
TOTAL	11,630

Second year

The projects to be carried out in the second year are experimental afforestation as continued from the first year and construction of fundamental facilities required for the production forest. From this year on, a sizable labor force and temporary forest workers in addition to stationed staff will be required.

- Examination of tree types for afforestation and experimental afforestation --- 50,000 shil.

- Land preparation of 3,500 ha for afforestation --- 700,000 shil.
  Digging up the topsoil, mowing undergrass, prospecting and dividing the area, etc.

- Construction of a 25 ha tree nursery --- 1,250,000 shil.
  Purchasing of fertile soil, installation of sunshades and irrigation systems.

- Construction of a 5,000 m^2 forest station --- 5,000,000 shil.
  Housing 4,000 m^2
  Office buildings and store houses 1,000 m^2

- Purchasing of 14,000,000 seedlings --- 840,000 shil.

- Construction of a 5 km access road to the forest station --- 3,600,000 shil.

- Staff training expenses - 50,000 shil.

- Purchasing of work tools --- 80,000 shil.

- Staff salaries --- 220,000 shil.

- Wages for temporary forest workers --- 60,000 shil.
  Clearing-up of the area after the preparatory works for afforestation, etc., 6,000 man-days.

- Administrative expenses - 50,000 shil.

DEVELOPMENT COST OF THE SECOND YEAR (1000 sh)

Development Cost	11,500
Recurrent Cost	400
TOTAL	11,900

Third year

The main project to be carried out in the third year is planting of trees in the areas prepared in the previous years.

- Planting of seedlings on a 1,000 ha area - 600,000 shil.
  Temporary forest workers, 30,000 man-days.

- Purchasing of 9,000,000 seedlings --- 540,000 shil.

- Repair and replacement of work tools --- 20,000 shil.

- Staff training expenses - 50,000 shil.
- Staff salaries --- 220,000 shil.
- Administrative expenses --- 20,000 shil.

DEVELOPMENT COST OF THE THIRD YEAR (1000 sh)

Development Cost	1,140
Recurrent Cost	310
TOTAL	1,450

Fourth year

The main projects to be carried out in the fourth year are planting of trees in the new area, supplemental planting and mowing of undergrass in the areas planted in the previous years.

- Planting of seedings on a 1,000 ha area --- 600,000 shil.

  Temporary forest workers, 30,000 man-days.
- Purchasing of 10,000,000 seedlings --- 600,000 shil.
- Supplemental planting and mowing of undergrass on a 1,000 ha area --- 30,000 shil.

  Temporary forest workers, 1,500 man-days.
- Repair and replacement of work tools --- 20,000 shil.
- Staff training expenses --- 10,000 shil.
- Staff salaries --- 220,000 shil.
- Administrative expenses --- 20,000 shil.

DEVELOPMENT COST OF THE FOURTH YEAR (1000 sh)

Development Cost	1,230
Recurrent Cost	270
TOTAL	1,500

Fifth year

The main projects to be carried out in the fifth year are planting and mowing of undergrass in the areas planted in the third and fourth years.

- Planting of seedlings on a 1,000 ha area --- 600,000 shil.

- Purchasing of 10,000,000 seedlings --- 600,000 shil.

- Supplemental planting and mowing of undergrass on a 2,000 ha area --- 40,000 shil.

  Temporary forest workers, 2,000 man-days.

- Repair and replacement of work tools --- 20,000 shil.

- Staff training expenses --- 10,000 shil.

- Staff salaries --- 220,000 shil.

- Administrative expenses --- 20,000 shil.

DEVELOPMENT COST OF THE FIFTHE YEAR (1000 sh)

Development Cost	1,240
Recurrent Cost	270
TOTAL	1,510

Sixth to tenth year

As in the fifth year, the main projects to be carried out in these years will be planting of trees in the new areas, supplemental planting, mowing of undergrass, chopping off of branches, etc.

- Planting of seedlings on a 4,000 ha area --- 2,400,000 shil

  Temporary forest workers, 120,000 man-days.

- Purchasing of 40,000,000 seedlings --- 2,400,000 shil.

- Supplemental planting, mowing of undergrass, and chopping off of branches on a total area of 25,000 ha --- 500,000 shiil.

- Repair and replacement of work tools --- 100,000 shil.

- Staff training expenses --- 50,000 shil.

- Staff salaries --- 1,100,000 shil.

- Administrative expenses --- 100,000 shil.

DEVELOPMENT COST OF THE SIXTH TO TENTH YEARS (1000 sh)

Development Cost	5,300
Recurrent Cost	1,350
TOTAL	6,650

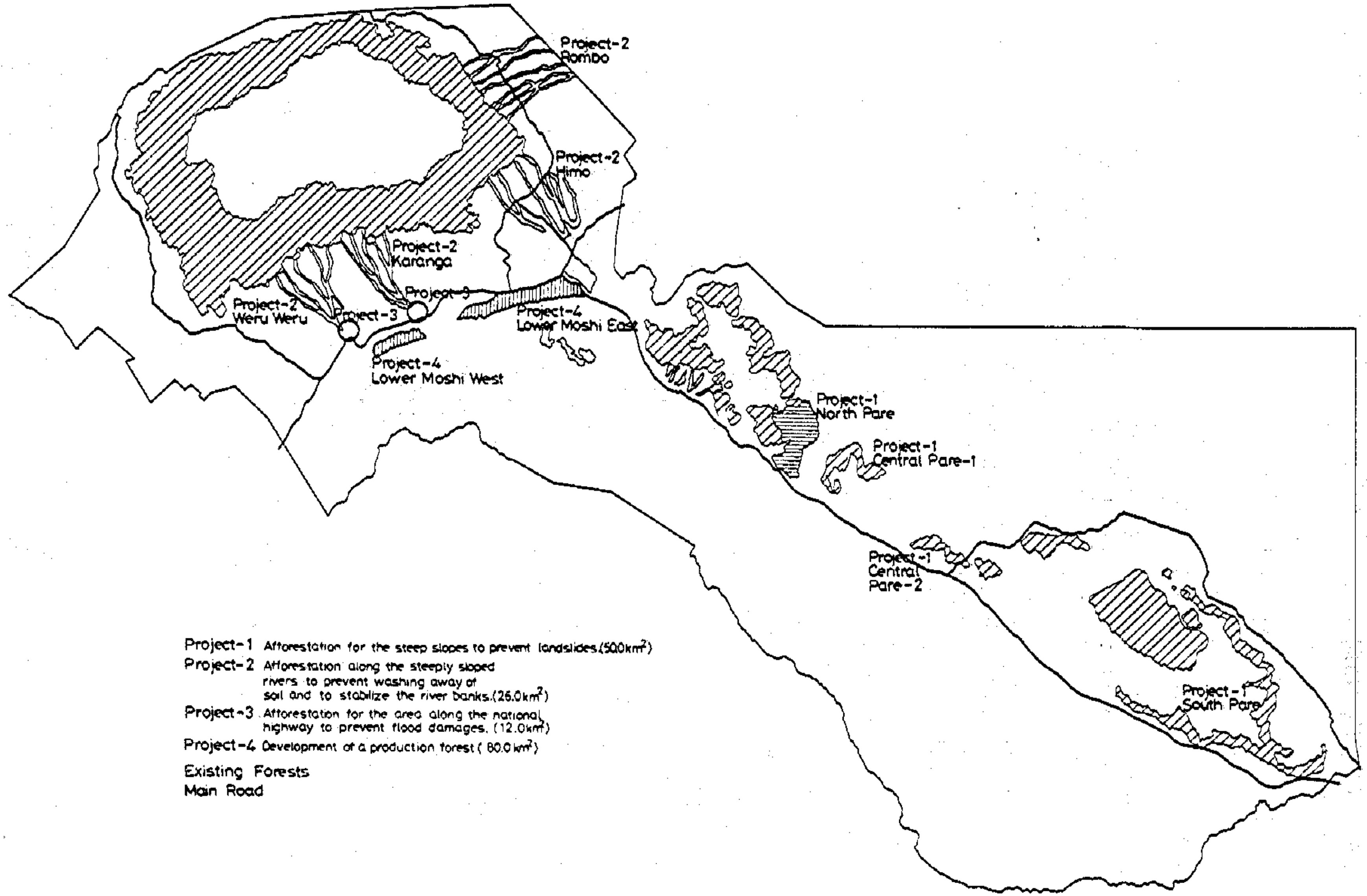
ANNUAL DEVELOPMENT COST (1000 sh)

	75	76	77	78	79	80-85
Development Cost	11,230	11,500	1,140	1,230	1,240	5,300
Recurrent Cost	400	400	310	270	270	1,350
TOTAL	11,630	11,900	1,450	1,500	1,510	6,650

ANNUAL DEVELOPMENT COST BY PROJECTS (1000 sh)

Development Cost	75	76	77	78	79	80-85
Project - 1	310	310	310	310	310	1,550
" 2	158	158	158	158	158	790
" 3	82	82	82	82	82	410
" 4	11,230	11,500	1,140	1,230	1,240	5,300
TOTAL	11,430	11,700	1,340	1,430	1,440	6,300
Recurrent Cost						
Project - 1	190	190	190	190	190	950
" 2	113	113	113	113	113	565
" 3	239	239	239	239	239	1,195
" 4	400	400	310	270	270	1,350
TOTAL	942	942	852	812	812	4,060
GRAND TOTAL	12,372	12,642	2,192	2,242	2,252	10,360

FORESTRY PROJECT PLAN 1985 (Fig.-20)



4. GAME CONSERVATION PLAN

4.1 The Need for Game Conservation

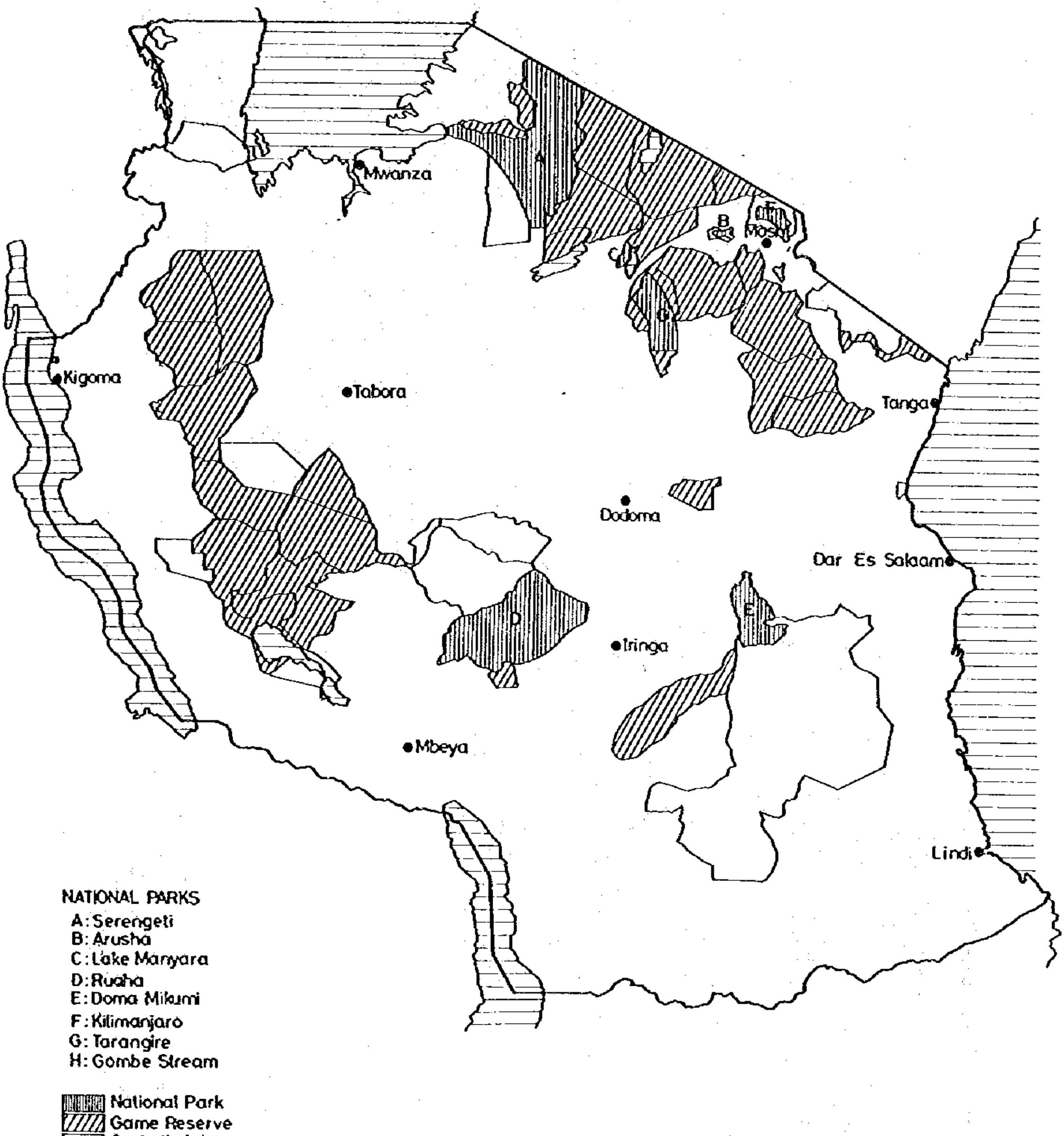
(1) National Parks and Game Reserves

The wildlife conservation plan outlined here is closely related with the tourism industry in Tanzania. Namely, its specatacular nature and rich wildlife are Tanzania's main tourism resources. The special attraction East A frica offers to tourists is close observation of wildlife, such as lions, elephants, rhinos, buffalo, and leopards, in their natural habitat. The following are the National Parks and Game Reserve areas in Tanzania at present.

National Parks	Area (Km2)
Serenget	13,000
Lake Manyara	1,320
Arusha	120
Kilimanjaro	756
Ruaha	13,000
Mikumi	1,300
Tarangire	2,600
Gombe	160

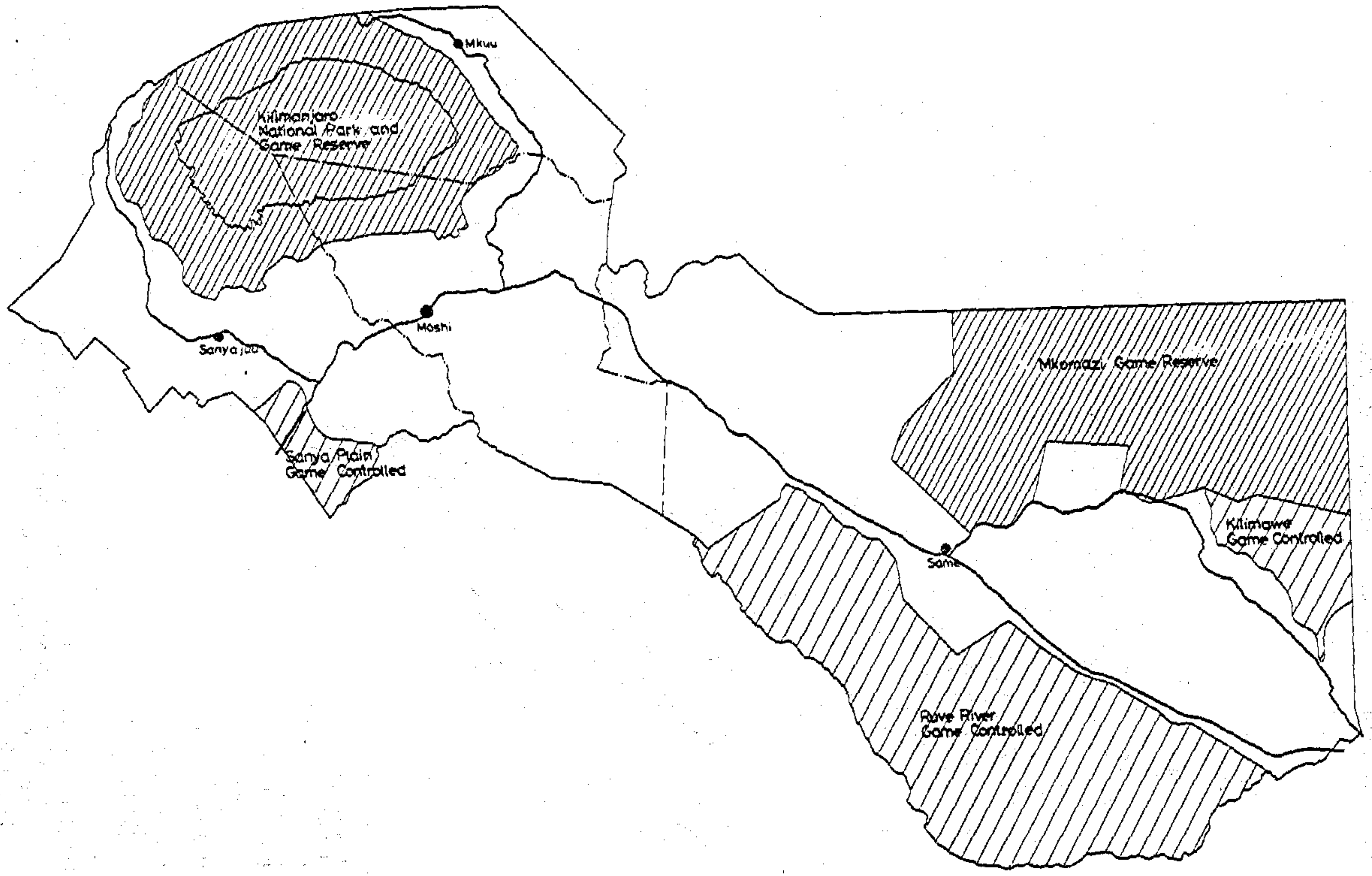
Game Reserves	
Selous	42,000
Rungwa	9,100
Mkomazi	1,940
Biharmiro	1,200
Katavi	1,700
Ugalla	4,700
Kilimanjaro	1,790

NATIONAL PARKS AND GAME RESERVES IN TANZANIA (Fig.-21)



Note: In National Park and Game Reserves wildlife is protected; construction of housing is not allowed and hunting is prohibited, though occasionally permitted in certain areas. The National Parks are administered by the state and Game Reserves, by regional authorities. Foreign visitors to these parks and reserves pay an entrance fee of 10 - 20 shillings.

NATIONAL PARK AND GAME RESERVE MAP (Fig.-22)



(2) Tourism Policy

The planning and execution of policies related to tourism are controlled by the Ministry of National Resources and Tourism.

Recently, tourism came to be emphasized among the general policies and to be regarded as an effective means to earn foreign currency.

The National Parks and Game Reserves are established based on these factors, to protect wildlife which is the most important tourism resource, as previously stated.

(3) Tourism Circuit

The numbers of visitors in a year to the main National Parks and Ngorongoro Conservation area are as follows:

The daily number of visitors to each National Park is limited for the conservation of wildlife.

	Limit of Numbers of Visitors
Serenget: National Park	600 persons
Ngorongoro Conservation Area	400 "
Lake Manyara National Park	250 "
Arusha National Park	150 "
Kilimanjaro National Park	250 "
Mikumi National Park	200 "

Annual Number of Visitors	1966	1967	1968	1969
Serenget:	11,634	16,247	21,889	28,981
Lake Manyara	21,718	29,267	33,898	41,864
Arusha	6,316	8,598	10,610	11,571
Ngorongoro	23,571	25,766	33,468	44,669
Mikumi	5,121	6,213	5,775	8,113
Ruaha	648	527	345	565

As seen in the above table, the largest number of people visited Ngorongoro and Lake Manyara, followed by Serengeti.
These three places are main tourism resources on the Northern Tourist Circuit. This indicates that these areas are the most attractive and at the same time easy for tourists to visit at present.

Though Mkomazi Game Reserve and Kilimanjaro National Park are not on this Northern Tourist Circuit, a new nothern tourist route including Mkomazi Game Reserve may be possible considering the promising future of the whole northern area including Mt.Kilimanjaro. Based on this future possibility, the Tanzania Tourism Bureau has plans to construct a tourist lodge on the eastern footland of Mt. Kilimanjaro as well as to increase the number of visitor's houses on the western side of the Mkomazi Game Reserve.

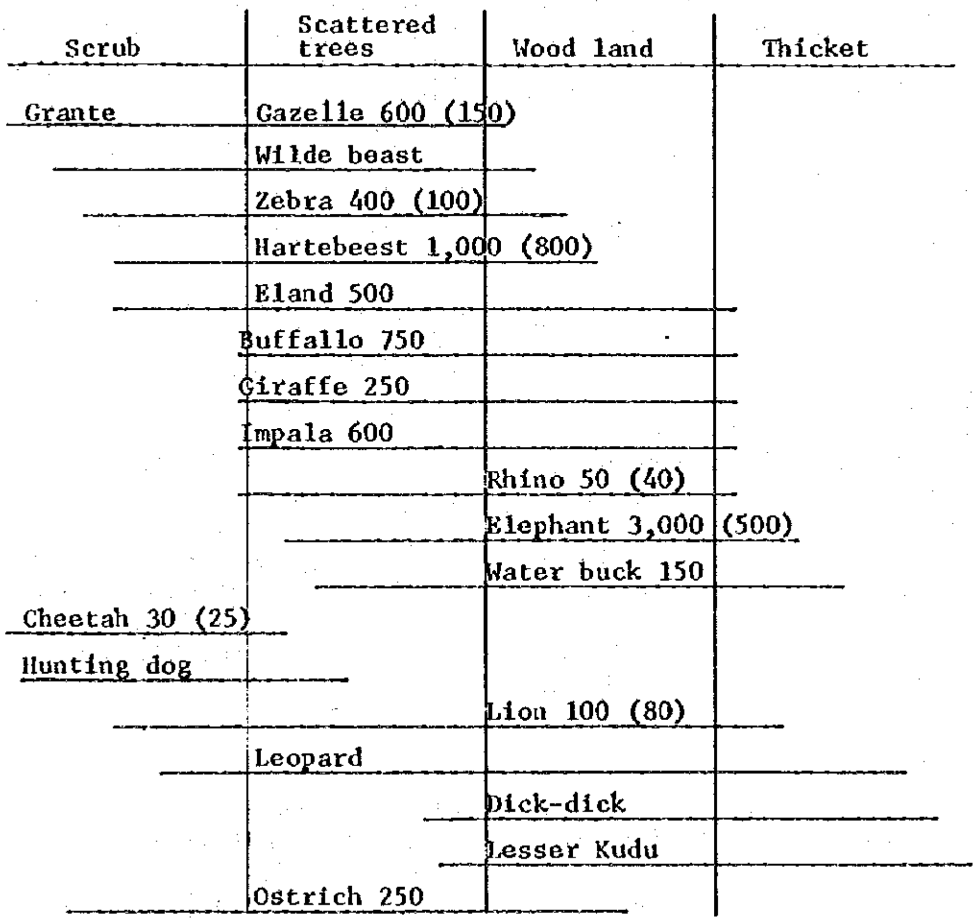
This exploitation of tourism resources will bring more foreign currency through foreign visitors, increase the employment opportunities of the local inhabitants, and accordingly raise their income. At the same time, it is possible to conserve the important tourism resources, natural environment, and wildlife in parallel with the exploitation.

4.2 Potential Analysis

The principal animals currently protected in the Mkomazi Game Reserve are:

Annimals	Giraffe, Buffallo, Elefant, Rino, Grants Gazelle Kongani. Oryx. Eland. Stainback. Dick dick. Ostrich. Impala. Zebra. Lion. Cheetah Hunting dog. Sevale Cat. Jannet. Bad-Yeared Fox. Hyena. Jackal. Leopard. Lesseckudu.
Birds	Francoline. Jin Girefo. Lesser and Greater Bustard Selvetary Bird. Sunday Grouse. Supard Starling. Kite. Owl . Bush Birds.

The distribution of habitats of these animals is closely related to the type of vegetation and may be roughly divided as follows:



The figures in ( ) shows the numbers in dry season

As stated before, there are comparatively many species of animals though their numbers are rather small due to the scant water supply. At the start of the dry and rainy seasons large-scale periodical migration of animals takes place. Many animals die during these periodical migrations in search of grass.

Migration of animals

- The migration of animals is roughly divided into two types: south-north and east-west migrations. In either type, animals start to migrate at the beginning of the dry season and return to the original area at the start of the rainy season.

In the Mkomazi Game Reserve area, these seasonal migrations are more extensive than in other regions, as stated before. However, the features of migration are different in the eastern and western parts of the Mkomazi Game Reserve.

As to the habitat conditions, the eastern part is poor in water resources and vegetation; consequently the bio-mass (total animal units) of animals is small. On the other hand, the eastern part of Killimanjaro State is supplied with abundant water from the Pare Mountains and from the permanent Mkomazi river flowing through it. Acco-dingly vegetation varies in kind and in type from mountain forest to grassland.

- South-north migration

Extensive south-north migration is observed especially in Mkomazi Game Reserve East among animals such as elephants, grante gazelles, zebras, rhinos, and hartebeasts. Migration starts in general in December around the beginning of the dry season, but this differs by species. Elephants migrate in large groups of about 100. Other animals form small groups. The destination is the comparatively water-rich savanna of Tsavo National Park West in Kenya. Animals travel more than 100 km to the destination. The south-north migration in Mkomazi Game Reserve is generally the same, but on a smaller scale. Most animals migrate northward to the Lake Jippe area in Kenya and southward to the rich green highland near the Pare Mountains.

- East-west migration

The east-west migration is smaller in scale than the south-north migration, though it involves almost the same animal species.

The east-west migration is also extensive in Mkomazi Game Reserve East. One destination is the Umba river area near the Usambara Mountains, another is the Mkomazi River area the Pare Mountains. As a result, there are almost no animals in the eastern part of Mkomazi Game Reserve during the dry season.

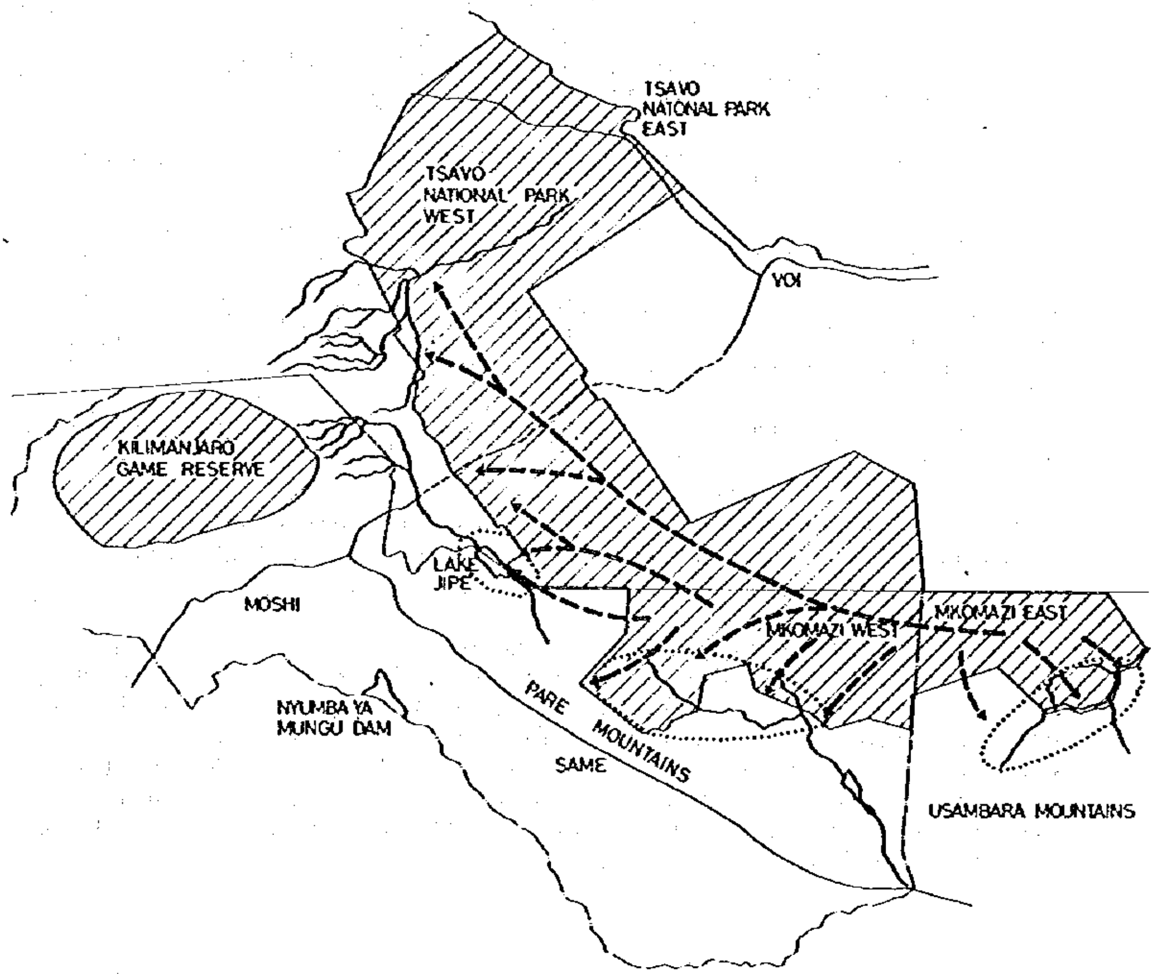
o Potential wildlife areas

From the animal migrations, it is understood that the western part of Mkomazi Game Reserve has higher potential than the eastern part. In the western part, the highland area at the foot of the Pare Mountains has especially high potential during the dry season. In Mkomazi Game Reserve West, the bio-mass of animals is larger during the dry season than during the rainy season because of animal migration from Mkomazi Game Reserve East.

As a result, the Mkomazi Game Reserve, in contrast to other National Parks and Reserves, shows a peculiar tendency of having a higher potential as a tourism resource during the dry season.

In addition to the high potential area near the Pare Mountains, it is assumed that the Lake Jippe area near Tanzania has very high potential. Therefore, long-term investigations of these areas will be necessary in the future, taking into consideration the ralationship with Tsavo National Park.

MIGRATION OF ANIMALS



4.3 Project Finding

Projects to be carried out by 1985 are to be determined by synthesizing the problem found in Mkomazi Game Reserve discussed before, and the facts that the area is planned to be but on the Northern Tourist Circuit and that Mkomazi West has high potential as a tourism resource.

Project 1. Overseas aid for the survery on wildlife and habitat.

The following is to be investigated:

(1) Accurate information on wildlife species, number, and migration patterns.

(2) Problems in environmental conditions for wildlife.

(3) Potential of the Lake Jippe area as a game reserve.

(4) Ecological bio-mass and control methods to maintain the balance, especially optimum number of elephants.

(5) Considering an estimated 20% rate of damage and withering of saplings.......

In Japan the rate is 20%, but is has been considered to be somewhat higher in Tanzania in view of the climatic, soil, and technical conditions obtaining there.

In Japan saplings are generally planted at a rate of 49 per square meter (190,000/ha).

Project 2. Water resources survey

Survey of groundwater resources to determine the possibility of constructing watering places and bore holes which are fundamental prerequisites for the existence of wildlife.

There facilities are aimed at minimizing the great problem of animal migration.

Project 3. Investigations and experiments to determine the potential of the game reserve areas as land for agricultural use, stock farming, and other human utilization.

These investigations and experiments are aimed at finding the most effective way for both wildlife and humans to coexist in the Mkomazi Game Reserve area. The task of the project is to eliminate the pressure on wildlife by excessive stock farming, etc. observed in the reserve area at present, and to exclude a part of Mkomazi Game Reserve with high potential for other human utilization from the Game Reserve area, Especially the Kishiwani area is to be investigated for this purpose.

Project 4. Construction of bore holes

Based on the results of the water resources survey, a long-term project will start to construct one bore hole per year.

Project 5. Increasing the number of visitor's rooms

An increase in the number of visitor's room is planned in connection with the possibility of putting the Mkomazi Game Reserve on the Northern Tourist Circuit in the future. The number of rooms is planned to be increase by 14 rooms in 10 years, in addition to the present 28 rooms, in accordance with the change in the number of visitors.

Project 6. Construction of a youth center for wildlife conservation

The purpose of this center is to educate native and foreign youth on natural conservation in the wider sense, including wildlife, and to serve as a wildlife museum.

Project 7. Overseas training of rangers

The purpose of this project is to give youths working as rangers the chance of overseas training (Japan) in the wildlife field and other experiences which will be useful for future wildlife conservation activities.

Project 8. Overseas financial aid for management

Financial aid for the management of Mkomazi Game Reserve will be provided by the wildlife conservation organizations in Japan, in case the prohibition of game hunting in the Reserve area causes financial difficulties.

4.4 Project Plans

Given below are the time schedules, scale and cost of the projects, as per (3) Project Finding, to be carried out by 1985.

Project 1. Survey on wildlife and habitat

Objective areas include the Mkomazi Game Reserve area, Lake Jippe area, and if possible the southern part of Tsavo National Park West.

The survey is to be conducted over a period of 10 years. Several Japanese advisors will make up a survey team in cooperation with the game officers, game conservators and game wardens of the study area.

The cost of the survey will be 540,000 shillings annually for 10 years, which will be supported by Japanese organizations for wildlife conservation.

Project 2 Water resources survey

Objective areas include the Mkomazi West and Lake Jippe areas.

The cost of the survey will be 270,000 shilling annually for a survey period of 2 years.

Project 3. Investigations and experiments to determine the potential of the area for human land utilization.

The objective is the Kishiwani area.
Details of the plan are to be decided after discussions with related agencies. The period of the project will be 5 continuous years. The cost will be 20,000 shillings per year.

Project 4. Construction of bore holes

Based on the results of Project 2 or water resources, about eight bore holes are to be constructed by 1985 at a rate of one per year.

The cost of construction will be 270,000 shillings for one bore hole.

Project 5. Increasing the number of visitor's rooms

The number of visitor's rooms is to be increased by 14 rooms in two buildings in the areas near Ibaya lodge and Kishima lodge.

One building will be approx. 80 m2 in area and construction costs will be 450,000 shillings. One maintenance worker is to be stationed at each new building. Personnel expenditures will be 18,000 shillings per year.

Project 6. Construction of youth center for wildlife conservation

The construction site will be near the Kishima area. The building will cover a floor space of approx. 250 m2. Construction costs will be 5,400,000 shillings. One curator, two assistant curators, and two maintenance workers will be stationed at the center and will be provided with housing nearby.

Housing for curator	1 bldg.	80 m2 x 1	21,000 shil.
Housing for assistant curators	2 bldg.	60 m2 x 1	16,000 shil.
Housing for maintenance workers	2 bldgs.	40 m2 x 2	18,000 shil.
		TOTAL	55,000 shil.

Personnel expenditures will be 198,000 per year.

Curator	1	108,000 shil./year
Assistant curator	2	54,000 shil./year
Maintenance worker	2	36,000 shil./year
TOTAL		198,000 shil./year

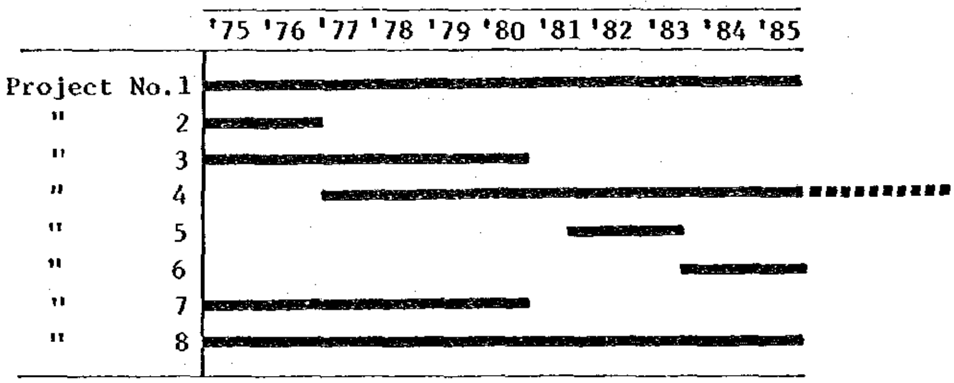
Project 7. Overseas training of rangers

Details of the training are to be determined in discussions between the governments of Tanzania and Japan.

Project 8. Overseas financial aid

Approx. 270,000 shil. annually for 10 years in financial aid for management expenditures is under consideration by the Japanese wildlife conservation organizations.

The time schedules of the above mentioned eight projects are shown in the following chart.



Yearly development costs of each project are as follows:

Projects Not On The Basis Of Foreign Aid (1,000 sh.)

	75	76	77	78	79	80-85	Total
Project-2	270	270					540
-3	200	200	200	200	200		1,000
-4			270	270	270	1,350	2,160
-5						450	450
-6						5,455	5,455
Total	470	470	470	470	470	7,255	9,605

Projects On The Basis Of Foeign Aid

	75	76	77	78	79	80-85	Total
Project-1	54.0	54.0	54.0	54.0	54.0	270.0	540.0
-7							
-8	27.0	27.0	27.0	27.0	27.0	135.0	270.0
Total	81.0	81.0	81.0	81.0	81.0	405.0	810.0

Annual Recurrent Cost

	75	76	77	78	79	80-85	Total
Project-5	18	18	18	18	18	90	180
-6	198	198	198	198	198	990	1,980
Total	216	216	216	216	216	1,080	2,160

GAME CONSERVATION PROJECT LOCATION MAP