Commission on Mountain Geoecology of the
International Geographical Union (IGU)
International Union of Biological Sciences (IUBS)
International Mountain Society (IMS)

# African Mountains Workshop
# Ethiopia
# 18 – 27 October 1986

# Excursion Guide

Addis Abeba University
Ethiopian Ministry of Agriculture
University of Berne

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## *List of Abbreviations*

| | |
|---|---|
| AMW | African Mountains Workshop (18-27 October 1986) |
| CFSCDD | Community Forests and Soil Conservation Development Department of the NRCDMD |
| ILCA | International Livestock Centre for Africa |
| m asl | metres above sea level |
| MoA | Ministry of Agriculture |
| NRCDMD | Natural Resources Conservation and Development Main Department of the MoA |
| SCRP | Soil Conservation Research Project (Berne University and CFSCDD) |
| WFP | World Food Programme |
| WRDA | Water Resources Development Authority |

# 1. INTRODUCTION

The field excursion of the African Mountains Workshop (AMW) is planned for 21 to 24 October 1986. It forms the central part of AMW and is preceded by a 3-day conference and followed by a 2-day discussion period. This Excursion Guide provides the itinerary, background information for some of the stops and maps for the field excursion.

The highlands of Ethiopia are divided into two parts by the Ethiopian Rift Valley. The funnel-shapped Rift Valley is wide in the northeast where it joins the Red Sea and the Gulf of Aden. But it narrows considerably in the southwestern part which is occupied by seven lakes.

The northwestern highlands run northeast-southeast to the west of the Rift Valley while the southeastern highlands follow the same direction to the east of the Rift Valley. North of Addis Abeba, which is on the central edge of the northwestern highlands, the eastern escarpment is sharp and more or less defined. But southwards the northwestern highlands almost merge with the Rift Valley and the eastern escarpment is not as steep and as well-defined as it is in the north. This physiographical fact has marked influences on variations in climate and mode of living as well as on human migration.

The AMW participants will have the opportunity to see a good part of the northwestern highlands, even though the most imposing and impressive parts, the Simen and the Choke massifs, will be left out.

On the road to northern Shewa and southern Wello the altitudinal and climatic extremes that characterise much of Ethiopia will become evident. The road will, at places, rise to over 3200m and fall at other places to 1200m. Such drastic changes in altitude are obviously associated with equally drastic changes in temperature conditions.

Most of the area along our route drains into the Awash River, the most Ethiopian of all the rivers in the country not only because it is almost totally within the borders of Ethiopia, but also because it supplies most of the hydroelectricity produced. The Awash Valley is also most important for irrigated agriculture. The lowlands which are hot and which have very scanty rainfall depend much on the rainfall and the rivers of the highlands.

The trip will provide a glimpse of Ethiopia with its national and variegated beauty, its rich and diverse cultures, and its formidable problems. In short one is tempted to say: the Ethiopian mountains are both a blessing and a curse.

*Newly-built houses in the villagisation programme.*

## 2. ITINERARY

### 2.1. Tuesday, 21 October 1986

07:00 Departure in front of Ghion Hotel (Addis Abeba)

07:00 - 08:30 Addis Abeba - Sendafa (35 km) - Kesem (62 km)

The bus traverses the young city of Addis Abeba through gently sloping terrain on the southern side of Intoto mountain. Part of the extensive Eucalyptus plantations which form a belt around the city may be observed. They are the sources for fuel and construction wood. The road follows altitudes of around 2500 m asl, crossing gently sloping plateaus where the dominant landuse type is grassland. Results of the villagisation programme of 1985/6 can be seen on the way (32 km from Addis Abeba, see photo). Problems of waterlogging on shallow soils are visible along the road. Aleltu village (56 km) is a centre for merchandising pulses, mainly lentils.

08:30 - 09:00 Stop 1 at Kesem catchment head (62 km). See page 21 and photos p.20.

09:00 - 10:30 Kesem - Sheno (75 km) - Debre Birhan (135 km)

A small Tuesday market in Hamus Gebeya (literally translated as "Thursday Market") near the road demonstrates the important function of such activities. Undulating plateaus and hillsides are intensively cultivated both for "Belg" (small rains) as well as "Meher" (big rainy season). Oats (Sinnar) have been introduced some decades ago and are spreading more and more due to their adaptability to the high altitude climate. In this part the altitude rises to 2500 and 2900 m asl. Grassland is dominant on the plateaus and on the valley bottoms. Frost and waterlogging constrain crop cultivation in such an environment. The International Livestock Centre for Africa (ILCA) has one highland station about 15 km before Debre Birhan.

10:30 - 11:00 Coffee break in Debre Birhan (Akalu Hotel)

*Outlook at Tarmaber from 3200 m asl down towards west into agricultural areas at 2500 m asl.*

*Extreme degradation of cultivated slopes in the highlands leaving only small strips for productive barley cropping.*

11:00 - 11:30 Debre Birhan (135 km) - Mush (162 km)

After crossing the undulating plateaus with high mountains extending up to 3700 m asl to the right and deep valleys down to 1500 m asl to the left, the road crosses a series of valleys starting from the southeast and extending to the northwest at altitudes of 2800 - 3000 m asl. Traditional irrigation from river diversions can be seen in some of the valley floors, mainly used at the end of the big rainy season to produce a second or third crop. Slopes become steeper and degradation of forest and agricultural soil is widespread (see photo). Afforestation programmes for the production of fuelwood for towns were initiated a few years ago.

11:30 - 12:00 Stop 2 at Mush Nursery. See page 25.

12:00 - 12:30 Mush (162 km) - Gudo Beret (167 km) - Tarmaber Escarpment (185 km)

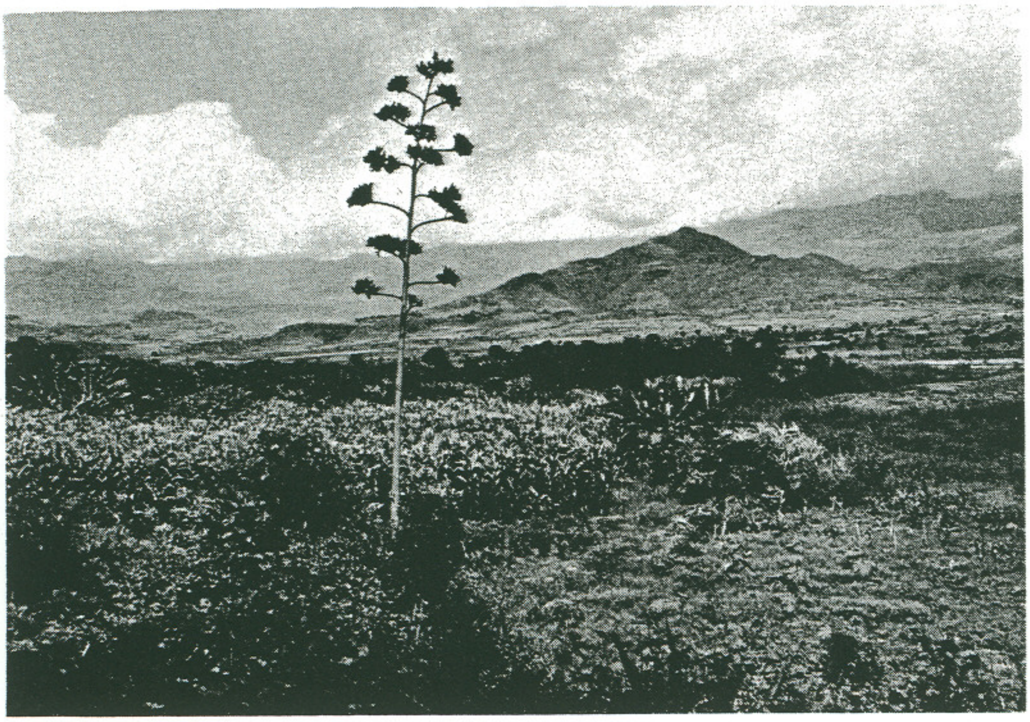
This highland area with many deep valleys crossed by the road at an altitude of about 3000 m asl has been selected for concentrated soil conservation and afforestation activities by CFSCDD of MoA since 1980 and supplied with grain and oil for "food-for-work" programmes by WFP. Many conservation structures can be seen from the road. The upper limit of cultivation is just below the highest point of the mountains at about 3500 m (170 km). Survival rates of planted Eucalyptus trees are sometimes low (175 km). A station of the Soil Conservation Research Project which is situated on the road (177 km) will be visited by part of the group on 23 October. The Tarmaber Escarpment offers an outlook into extremely steep escarpments towards southeast, down from 3250 m asl into the Awash valley situated at about 800 m asl (see photo). Conservation and afforestation activities are abundant around the site. Land cover distribution patterns varying according to altitude and local conditions are illustrated in the land cover map of Debre Birhan area (1:100'000, see folder).

12:30 - 13:30 Lunch at Tarmaber escarpment outlook

13:30 - 14:30 Tarmaber (185 km) - Debre Sina (195 km) - Robit (225 km)

The road crosses the watershed between the Blue Nile and Awash rivers through a tunnel (190 km from Addis Abeba) and descends with a series of serpentine curves from 3200 m asl down to 1400 m asl. A number of cultivation belts are crossed. The "Wurch" belt, with only barley merges into the "Dega" belt with a mixture of grains and pulses, then into the "Weyna Dega" belt with maize and tef (Eragrostis tef) as main crops, and finally into the "Kolla" belt with sorghum and tef as main crops (see photo p.6). River diversions can compensate for reduced rainfall in the Kolla belt.

14:30 - 15:00 Stop 3 near Robit (225 km). See page 26.



*Sisal, maize, bananas and many other useful plants can be grown near (Shewa-)Robit at 1400 m asl*

*Degradation, drought and famine - a vicious circle? All elements are shown on this photo taken in Kelkelti (265 km from Addis Abeba).*

15:00 - 16:00 Robit (225 km) - Effeson (280 km)

The road follows the foot of the escarpment of the Rift valley crossing several valleys which descend into the Danakil desert to the right. Altitudes vary between 1300 m and 1700 m asl. Sorghum is intensively cultivated. Problems of charcoal production and deforestation become obvious. Remnants of a famine relief camp are seen on the road (see also photo).

16:00 - 16:30 Coffee break at Effeson (280 km)

16:30 - 18:00 Effeson (280 km) - Fontanina (370 km)

The travel continues along the foot west of the escarpment. Major faults which preconditioned valley floors with swampy areas are used during droughts by nomadic people and their herds ascending from the semi-desert to this altitude. The biggest of the swamps is the lower Borkenna river situated at about 1500 m asl (see photo p.8). Along the road, area closures of steep slopes organised through CFSCDD lead to regeneration of bushy vegetation and grasses. Cheffa State Farm is crossed at 350 km from Addis Abeba (see photo p.8). New villagisation schemes are seen at Addis Mender which were set up to form producer's cooperatives (365 km).

18:00 - 18:30 Stop 4 near Fontanina. WRDA Borkenna dams construction sites (370 km). See page 28 and photo.

18:30 - 19:00 Fontanina (370 km) - Kombolcha (375 km)

19:00 - 20:30 Dinner in Tekle Hotel (Kombolcha)

20:30 - 21:00 Kombolcha (375 km) - Desse (400 km)

21:30 - 22:00 Discussion on the experience of the day and preparation of the next day's activities.

Overnight in Desse.

*View of the lower Borkena swamp at 1400 m asl - a refuge for nomadic grazing in higher areas during periods of heavy drought.*

*Chefa State Farm - mechanised farming (here Eragrostis tef) as a heritage of large-scale farming since the 1950ies.*

## 2.2. Wednesday, 22 October 1986

| | |
|---|---|
| 07:00 | Breakfast at Ambassel Hotel |
| 08:00 - 19:00 | Field trip in Wello Region. Two options. The first option is by bus along the main road towards the north. The second option is by 4-wheel drive vehicles and on foot (3 km) towards the west. |

### *O p t i o n 1:*

Ambassel is a province in central Wello. It has three clearly distinguishable parts: the western mountainous part which rises to over 3500m, Ambassel proper, the central part where there are two beautiful lakes, and the eastern part, Werrebabbo, which is very low, falling to less than 1000m asl.

For a very long time Ambassel Province had a very serious problem of population pressure, especially in the higher and more favourable western and central parts. Even the steepest slopes were cultivated with small hoes and the result was a very serious degradation of the land. Now there is a considerable change in the landscape due to the closure of the steep slopes for natural regeneration and reafforestation.

One of the charms of Ambassel is its cultural diversity, a manifestation of various linguistic and religious groups as well as the different cultures of nomadic pastoralists and peasant cultivators. The monastery of St. Stephen on a little island in one of the lakes (Hayk) gives the province some historical importance, because the monastery is a very old one, going back several centuries.

Lakes Hayk (2030m) and Ardibbo (2100m) provide a beautiful scenery. Hayk is nearly 7 km long and about 5 km wide. Ardibbo is almost 8 km long and only about 2.5 km wide. The two lakes are separated by a distance of about 8 km.

### *O p t i o n 2:*

Trip to western highlands and mountains with 4-wheel drive vehicles and on foot (1 hour), using mainly rural roads and trails. Accompanied by the Zonal Representative of MoA, Ato Tegegn Desta.

08:00 - 09:00 Desse - Tossa Fellana escarpment (32 km)

7 km after leaving the regional capital Desse, a road to the south across a tributary of the Blue Nile is taken descending into a flat valley. Problems of gullying,

*View of Borkena II dam project (spillway in center of photo) - Government reaction to the 1984 drought situation.*

*Leucaena bushes as a strategy to make soil conservation structures stable and productive - suitable in lower lying areas.*

torrents, and possible solutions with afforestation and soil conservation may be observed. Further on, a ridge forming the main watershed between Awash (Borkenna) and Blue Nile (Beshlo) will be reached at an elevation of about 2700 m asl.

09:00 - 09:15 Stop for a view of the Tossa Fellana catchments (see photo p.12).

As we look into the catchments we shall have the opportunity to discuss the following:
- Afforestation and soil conservation
- Traditional patterns of landuse
- Potential for irrigation

09:15 - 10:00 Tossa Fellana escarpment (32 km) - Tebasit (60 km)

The road follows the main watershed reaching an elevation of almost 3600 m asl.

10:00 - 10:30 Stop at the highest point of the road. Afro-alpine environment at 3600 m asl.

The following topics can be discussed:
- Afforestation and soil conservation
- Traditional patterns of landuse
- Potential for irrigation and water storage

10:30 - 11:30 Tabasit (60 km) - back to Tossa Fellana escarpment (88 km) - Golale (2700 m asl, 95 km)

11:30 - 12:30 Walking down the Kori Sheleko catchment to Abbo Ager Station (2500 m) of SCRP (2 km)

While walking down, the following topics are demonstrated and discussed during short stops: Deforestation, soil erosion processes, steepland cultivation, cutoff drain construction, area closure, afforestation, soils and soil conservation.

12:30 - 13:30 Lunch at Research Station.

13:30 - 14:30 Problems of Abbo Ager area. See page 30.

The following topics are demonstrated and discussed: Field verification of agro-ecological landuse planning. Scenarios of the year 2010. Age of cultivation. Soil profile observations and map interpretations. Soil erosion testplot studies. Soil conservation experiments and first results. Effects of 1984/85 drought situation. Activities to prevent famine. Resettlement. Irrigation (see photo p.12).

14:30 - 15:00 Walk along lake shore (1 km) through irrigation pumping scheme (20 ha).

*View of the Tossa Fellana catchment (Option 2) - typical environment along the eastern escarpment region with steep slopes and flat bottom land suitable for crop cultivation.*

*Irrigation structures using natural lakes for periods of insufficient rainfall - a disaster prevention programme as implemented around lake Maybar (Option 2).*

The following topics are demonstrated and discussed: Problems of irrigation in a high rainfall area and gently sloping irrigable land, including drainage, soils, crop requirements, prospects for horticulture and possibilities for supplementary irrigation during drought periods.

15:00 - 16:00 By car from Maybar (100 km) - Yegof mountain (3002 m asl, 115 km)

Climbing by car back up to the main watershed, then around the research catchment towards the east, following the ridge to Mount Yegof, a location where afforestation started in 1974.

16:00 - 16:30 Visit "old" afforestation site around Yegof mountain.

16:30 - 17:30 Yegof (115 km) - Kombolcha (130 km)

Steep descent along afforested sides of Mt Yegof to the gentle footslopes with intensive cultivations of a variety of crops on black soils, then to Kombolcha.

18:00 - 18:15 Kombolcha - Borkenna gorge (143 km)

An industrial centre is being developed on agricultural land west of Kombolcha. Trials of soil conservation and bund stabilisation with leguminous bushes (Leucaena, see photo p.10) are carried out at a site on the main road (140 km). The road continues uphill in a series of steep serpentines along one side of Borkenna valley towards Desse, the regional capital of Wello Region (2600 m asl).

18:15 - 18:30 Stop near Borkenna gorge (143 km)

See photo on the cover in this Excursion Guide.

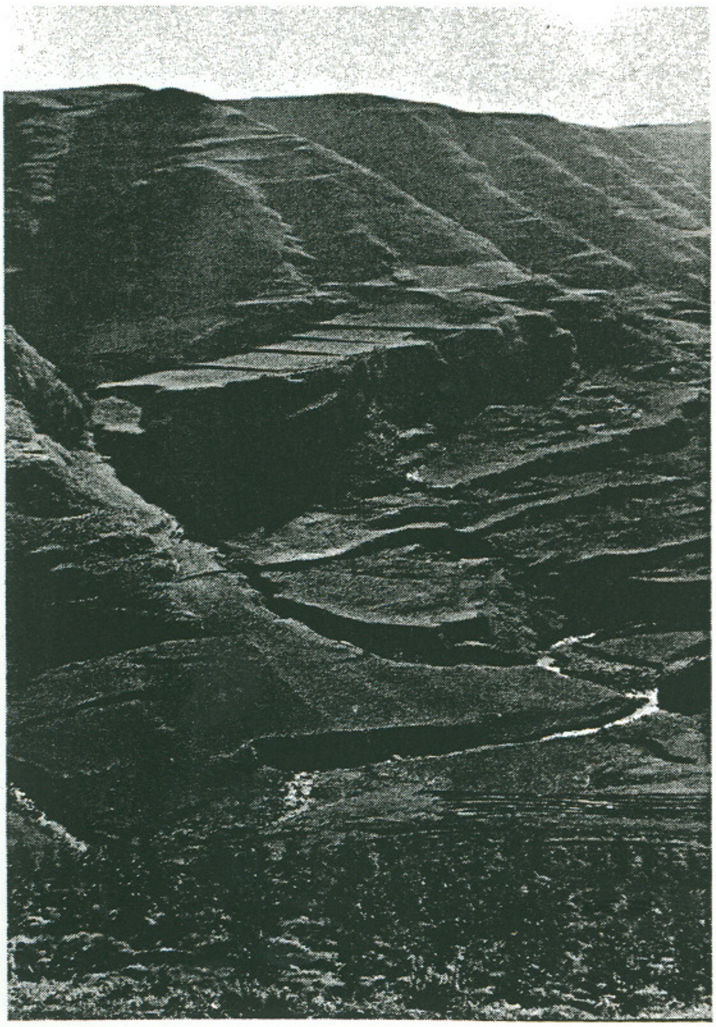
18:30 - 19:00 Borkenna gorge (143 km) - Desse (155 km)

19:30 Dinner in Ambassel Hotel (Desse)

21:00 - 22:00 Discussion of the day and planning of the next day.

Overnight in Desse.

*Optical impression of the Kemisse weekly market and its diverse visitors.*



*Highland agriculture along the road to Mehal Meda - century-old deforestation and extension of cultivations to the extreme are now being tackled with new afforestation as seen in the foreground (Option 1).*

## 2.3. Thursday, 23 October 1986

| | |
|---|---|
| 06:30 | Breakfast at Ambassel Hotel (Desse) |
| 07:30 - 09:00 | Departure by bus from Ambassel Hotel - Kemisse (75 km) |
| 09:00 - 10:00 | Kemisse weekly market. See page 42 and photo. |
| 10:00 - 13:00 | Kemisse (75 km) - Effeson (120 km) - Robit (175 km) - Debre Sina (210 km) - Tarmaber (220 km) |

The same road is used as for the trip on 21 October passing through the lowland footslopes along the western escarpment of the Rift valley system.

| | |
|---|---|
| 13:00 - 14:00 | Lunch at outlook of Tarmaber escarpment |
| 14:00 - 17:00 | Two options. The first option is by bus along the road to Menz and Gishe Province, following the main escarpment on top of the ridge, and back to Tarmaber. The second option is on foot (4 km) through the highland research catchment of SCRP to the research station on the main road. Both groups meet at the station at 17:00 and continue their trip to Debre Birhan. |

### *Option 1:*

Most of Menz-Gishe Province is mountainous rising to over 3000m asl. It is one of the best examples not only of very much dissected and rugged mountains, but also of the hard life on mountains.

This trip to the southern and the only accessible part of Menz-Gishe Province will give us a glimpse of the hard life of the Menzes that is proverbial. Even now, with the exception of the single road that zigzags up and down to Mehal Meda, some 102 km from Tarmaber, Menz-Gishe remains almost immune to modernisation.

The hardy people of Menz-Gishe eke out a living by cultivating their small fields on the slopes (see photo). Except deep down in the valleys the mountain slopes can only produce one cereal, barley. But beans and peas are also important.

Menz-Gishe is also famous for its fattened sheep. Various environmental factors combine to make sheep rearing a very important aspect of the economy. Traditionally, sheep are raised not only for mutton but also for wool which the

*"Gai" system of burning organic residues and dung in heaps of soil - a traditional means of improving soil fertility - especially phosphorus availability (Option 2).*

*View of Andit Tid Station of the SCRP situated at 3100 m asl, with widespread soil conservation measures implemented in 1984.*

people weave into "bana", blanket, to withstand the very cold and windy weather. Wool was also important for making "bernos", a sort of cape traditionally worn by the upper class men and women.

*Option 2:*

From lunch place the group is taken 5 km by bus to the top of the Hulet Wenz catchment and dropped there (3240 m asl), to walk through the upper catchment (1 km), where undisturbed Andosol soil profiles and graded conservation structures can be observed. Highland agriculture and soil improvement systems through burning of organic material may be seen (see photo). Outlook into the steep escarpment to the southeast (3250 m asl). Afroalpine bushes and grassland.

Hulet Wenz area information see page 43.

The walking continues slightly upwards to the highest village, Wani Gedel, at 3400 m asl (1 km). Discussions with farmers on agriculture and development will be possible. Livestock numbers are significantly higher than in the lower lying areas. The highlands also serve as major production areas of grass used for thaching roofs. The need for soil conservation on cultivated land will be discussed along the route.

From Wani Gedel, a steep trail is taken down to Astoch (3160 m asl, 1 km), where erosion studies on testplots were carried out since 1983. The data are presented on page 53. Degradation during many centuries is demonstrated by the present day damages. The effects on crop production were assessed. The age of deforestation and cultivation was determined. Catchment runoff and sediment loss data are available for the years 1982-1985. The effects of conservation on catchment hydrology and sediment loss can be discussed using available data (see page 51).

The two groups of Options 1 and 2 will meet at Andit Tid Research Station (see photo).

17:30 - 18:30 Andit Tid (225 km) - Debre Birhan (265 km)

Hotel accommodation in small hotels in Debre Birhan (2800 m asl)

19:30 Dinner in Akalu Hotel

21:00 - 22:00 Discussion of the day and planning of next day.

*Surface cracking typical for Vertisols - water management at dry and at wet times being the main critical issue for improved agriculture.*

*Close view of Menagesha State Forest - 300-year old stands of Junipe-rus trees mixed with Olea and Podocarpus.*

## 2.4. Friday, 24 October 1986

07:00 Breakfast at Akalu Hotel

08:00-09:00 Departure from Akalu Hotel - Denneba (45 km)

The bus leaves the main road at the outskirts of Debre Birhan and follows very gently undulating plateaus towards the west, through an intensively cultivated area. Dominant features are the degraded hilltops where there are villages. The slopes of the degraded hills have black soils (see photo) and are cultivated. But the plains which are covered with grassland are used for grazing livestock. The area also forms a border and merging of two peoples, the Oromo on the southwestern plains, and the Amhara in the northeastern valleys and ridges.

09:00 - 09:30 Vertisol management research of ILCA. See page 56.

09:30 - 13:00 Denneba (45 km) - Debre Birhan (90 km) - Addis Abeba (225 km)

The same route is taken as in the morning and on 21 October.

13:00 - 14:00 Lunch in Addis Abeba (Kokeb Restaurant)

14:30 - 15:30 Addis Abeba (Kokeb Restaurant, 225 km) - Holetta (270 km)

Traversing the town and its Eucalyptus belt, the route goes westward on the main road of Wellega Region, passing undulating terrain with mixed landuse types, where also water storage facilities for Addis Abeba were developed.

15:30 - 16:00 View of Mennagesha State Forest from the main road. See page 58 and photo.

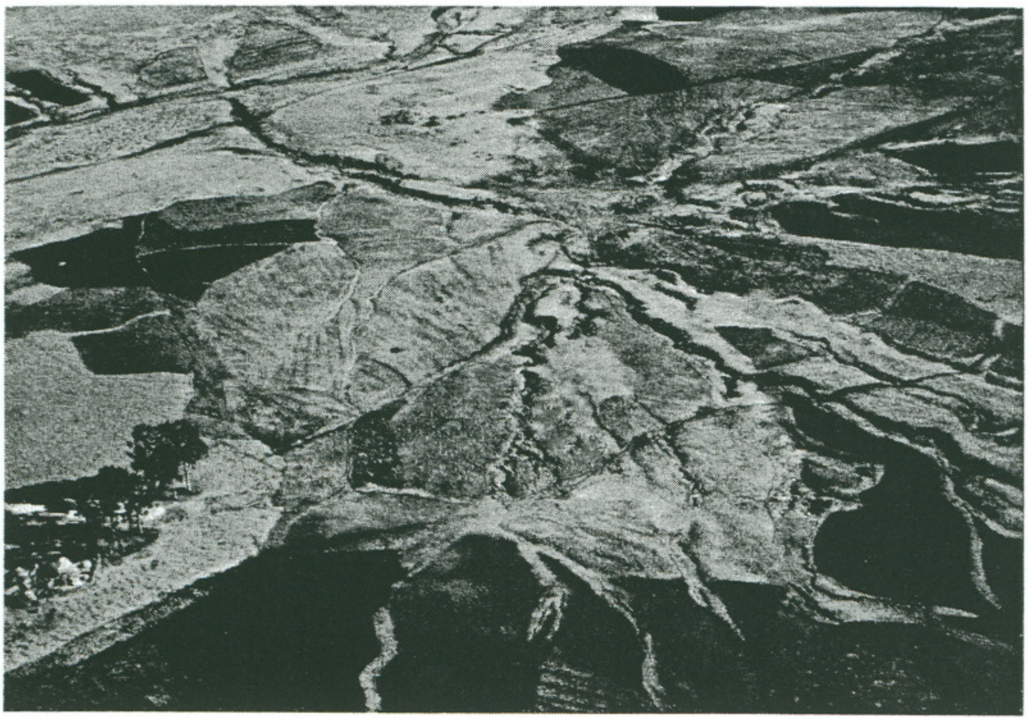
16:00 - 17:30 Holetta (270 km) - Ambo (345 km)

Accommodation in Ghion Hotel. Possibility to refresh in swimming pool (mineral water).

19:30 Dinner in Ghion Hotel

21:00 - 22:00 Discussion of the day and workshop topics.

Overnight in Ghion Hotel in Ambo (2100 m asl)



*Upper part of the Kesem catchment. Intensive cultivations and increasing gullies are typical for this part.*

*Lower part of the Kesem catchment. Cultivations are concentrated on terraces constructed into the valleys, while the grazing areas between the valleys are heavily overutilised.*

# 3. BACKGROUND INFORMATION

## 3.1. Stops on Tuesday, 21 October 1986

### *(1) Kesem Dam Project*

For more than 20 years there was a plan to construct a large dam on the Kesem river, a major tributary of the Awash. The planned dam is located in the lowland area at the foot of the eastern escarpment at about 800 m asl. It should provide a reservoir of some 500 million m3 of water collected from some 3135 km2 catchment area. From this reservoir, some 20'000 ha could be irrigated in the Awash valley.

The road Addis Abeba - Debre Birhan crosses the Kesem catchment through its headwaters between Sendafa (35 km) and Sheno (70 km) at an elevation of about 2700 m asl.

The stop is 62 km from Addis Abeba at an elevation of 2870 m asl. From there, the upper part of the watershed can be seen from the highest point at 3595 m asl in the eastern part to about 1500 m asl, before the river turns to the left and enters a long gorge descending down to the dam site at 800 m asl.

Numerous investigations were carried out during the past 20 years and some measurements were done on hydrology and sediment yield of the river. The latest assessment of sediment yield was carried out by Prof. Dr Malcolm Newson of Newcastle University, England; its results have not yet been published.

Some rough results, however, can be given here from previous investigations and personal communications.

| | |
|---|---|
| Lowest point: | 850 m asl |
| Highest point: | 3595 m asl |

| Altitude: | Area: | Main landuse types: |
|---|---|---|
| Below 1000 m asl | 141 km2 | Nomadic grazing |
| 1000 - 1500 m asl | 376 km2 | Grazing, some cultivations |
| 1500 - 2000 m asl | 922 km2 | Terraced cultivations |
| 2000 - 2500 m asl | 862 km2 | Intensive cultivations |
| 2500 - 3000 m asl | 749 km2 | Intensive cultivations |
| Above 3000 m asl | 85 km2 | Grazing, some cultivations |
| Total | 3135 km2 | Mixed |

Major problems in planning the dam can be listed as follows:

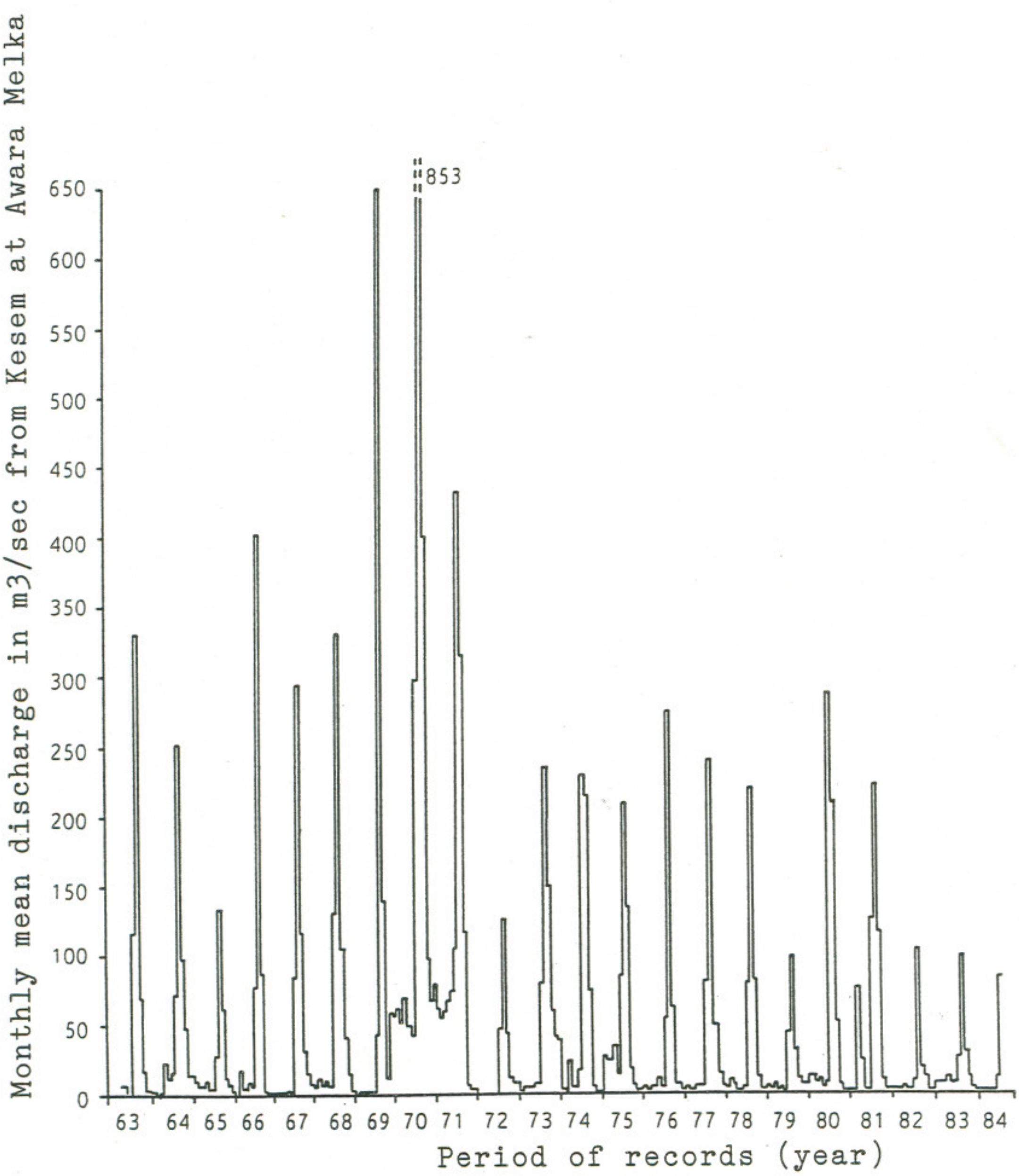
1. What life expectancy can be foreseen until the dam is silted up?
2. What relationship exists between bedload and suspended sediment load?
3. What is the major sediment source and how can it be controlled?
4. Where is the major sediment producing area?
5. What methods of flushing the dam must be included in the design?
6. How is the water quality for irrigation?
7. How is the quality of the soils in the irrigated area?
8. Are there problems related to local agriculture in the reservoir area?

Of the many problems, only few were studied in detail, while others remained very general and indicative. For example, dam siltation is predicted to fill the reservoir within 41 to 536 years according to the various assessments listed below.

| Author | Year | Suspended (mio t/yr) | Bedload (mio t/yr) | Total (mio t) | Time Years |
|---|---|---|---|---|---|
| 1. Sogreah | 1965 | 5,37 | - | 5,37 | 135 |
| 2. Fleming | 1969 | 1,35 | - | 1,35 | 536 |
| 3. Nedeco | 1982 | | | 9,45 | 53 |
| 4. Agrocomplect | 1984 | 5,95 | 2,38 | 8,32 | 87 |
| 5. LUPRD | 1984 | 17,74 | - | 17,74 | 41 |
| 6. Newson | (unpubl.) | 4,13 | 3,41 | 7,53 | 96 |

*Table: Overview on sedimentation estimations in the Kesem catchment calculated in the past 20 years.*

Another major problem is the variability of river discharge as seen in the graph on the next page.




*Graph:* *Monthly mean discharge of the Kesem river at Awara Melka for the years 1963 to 1984*

Although there exist comparatively well documented data on the Kesem river, they are still insufficient for a proper estimation of the economic feasibility and the environmental impact of such a major scheme. Clearly, the need for research strategies emerges in relation with such projects.

The following questions should be discussed by AMW:

1. What are the minimum data needed for the various problems outlined above?
2. What research methods are suitable to attain reliable results?
3. How could a research strategy be built into the planning process?
4. How could the research results be effectively fed into decision making?

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*(2) Mush Tree and Forage Nursery*

Mush Nursery (162 km from Addis Abeba) is located near the perennial river Mewkerya, a tributary of the Blue Nile, at 2950 m asl, on the main road from Debre Birhan to Debre Sina. The nursery was established by the Gado Project of CFSCDD (see below) in April 1982 and occupies an area of 2.5 ha.

Outputs of the Nursery 1982 - 1985:

3'528'600 tree seedlings
Grass sods and seeds used to cover 232.3 km of soil bunds

Types of tree seedlings raised:

Eucalyptus globulus, Eucalyptus saligna, Cupressus lusitanica, Juniperus procera, Acacia decurrens, Acacia saligna, Hagenia abyssinica totally (1.5 million per year)

Types of forage species raised:

Phalaris, Kikuyu, Kenya white clover, Alfa alfa, Rye grass, Cocksfoot, Demeter fescue (output see above)

*The Gado Project*

The Gado Project of CFSCDD is a soil conservation implementation project with inputs supplied by the WFP. Between 1982 and 1985, the Project achieved the following works:

| Type of work | Amount | WFP inputs Grain (tons) | Oil (liters) |
|---|---|---|---|
| Soil bund | 5'252 km | 1'103 t | 44'115 lt |
| Stone bund | 114 km | 51 t | 2'052 lt |
| Fanya juu | 261 km | 196 t | 7'830 lt |
| Hillside terrace | 1'302 km | 586 t | 23'427 lt |
| Maintenance | 825 km | 37 t | 1'484 lt |
| Tree planting | 3.53 mio | 159 t | 6'351 lt |
| Forage planting | 232 km | 12 t | 465 lt |
| Area closure | 34 ha | - | - |
| Checkdam | (?) 240 m | 0.14 t | 6 lt |
| Feeder road | 16 km | 96 t | 3'840 lt |
| Road maintenance | 6 km | 9 t | 360 lt |

*Source of Information: CFSCDD*

### *(3) Lowland Agriculture near Robit*

After descending down from 3300 m asl to the foot of the eastern escarpment of the main highlands, a lowland agricultural environment is reached near (Shewa-)Robit at an altitude of 1400 m asl (225 km from Addis Abeba).

Higher temperatures, still sufficient rainfall and the possibility to irrigate from river diversions provide a favourable environment for many crops such as tef, maize, sorghum, pulses, pepper, but also for cash crops like bananas, sisal, and under irrigation, tobacco, sugar cane, avocado and citrus trees.

Lowland areas, however, pose increased problems of diseases, especially associated with water supply from rivers (see photo).

Increasing problems of malaria exist at altitudes below about 1800 m asl. The sorghum producing altitudinal belts are also a major habitat of the weaver birds (Quelea), which have to be chased away from ripening fields, either

*The river as source of drinking water is a threat to human health especially in the lowland areas.*

through guarding as shown in the photo below, or through destroying their nests at breeding time, or even chemically through spraying in larger agricultural fields with mechanised farming systems.

*Careful guarding is needed at the ripening stage of sorghum in lowland areas in order to protect the crop from bird attack, especially by Quelea (weaver birds).*

### *(4) Borkenna Dams' Project*

The Borkenna Irrigation Development Project is a programme of the Ethiopian Government implemented without any foreign assistance. The idea to use this river for irrigation came up in the drought year 1984 and the work was started in November 1985. The first dam should be closed at the end of 1986, while the construction should be finished before the rainy season of 1987.

The Project was designed by the Ethiopian Water Resources Development Authority and the construction itself is carried out by the Ethiopian Water Works and Construction Authority.

The Borkenna river coming from north of Desse is going to be dammed with a series of three earth dams for irrigation in the Borkenna plain (south of Kombolcha, see map).

The catchment area of the lowest dam site, called Borkenna I, is 465 km2. 20 mio m3 will be stored by the dams and used for irrigation. For the irrigation scheme three options are foreseen:

1. For producing maize/sorghum, a total area of 5'500 ha could be irrigated.
2. With double cropping, the irrigated area would be reduced to 1'200 ha.
3. If rice is planted, the total irrigated area would be 850 ha.

Preference seems to be given to the double cropping system applied on 1200 ha. Some details about the 3 dam sites are given in the Table below.

The following considerations can be made from the preliminary data existing:

1. Assuming 1000 mm annual rainfall and a 20% runoff rate one can predict 100 mio m3 of runoff per year at the construction site. With the total storage capacity of 20 mio m3, or 6 mio m3 in the uppermost of the dams, it can be foreseen that much of the runoff will overflow the dams through the spillways, while much of the sediment and bedload remains in the reservoirs, especially in the uppermost reservoir.

2. With an estimated sediment yield of 1000 t/km2/year the upper dam, Borkenna III, would probably be filled with sediment within 12 years. The EWRA is aware of this and plans to excavate the sediment periodically. No cost estimations are given for such work.

A sketch-map 1:250,000 on the next page shows the catchment area, the dam site and the irrigable area.

The photo shows a view of the construction site of Borkenna II, especially the spillway (p.10).

*Source of Information:*

Borkenna Irrigation Development Project, WRDA

| S.No. | NAME OF THE DAM | HEIGH AT MAXIMUM SECTION (M) | CAPACITY | | CREST LENGTH (M) | AREA TO BE SUM-ERGED (ha) | COMPACTED EMBANKMENT VOLUME($M^3$) | DESIGN FLOOD DISCHARGE ($M^3$/sec/ | SPILLWAY PARAMETRES | | SPILLWAY CONTROLLING SECTION HEIGHT (M) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TOTAL STORAGE $10^6$ $M^3$ | LIVE STORAGE $10^6$ $M^3$ | | | | | CREST LENGTH (M) | OPERATING HEAD (M) | |
| 1 | BORKENA I | 18 | 1.8 | 1.5 | 465 | 25 | 350,000 | 300 | 100 | 1.5 | 1.00 |
| 2 | BORKENA II | 31 | 12.0 | 11.5 | 458 | 89 | 555,000 | 342 | 100 | 1.5 | 1.00 |
| 3 | BORKENA III | 25 | 6.3 | 6.0 | 432 | 79 | 400,000 | 342 | 100 | 1.5 | 1.00 |

*Table: Specifications of the Borkenna dams (catchment area is 465 km2).*

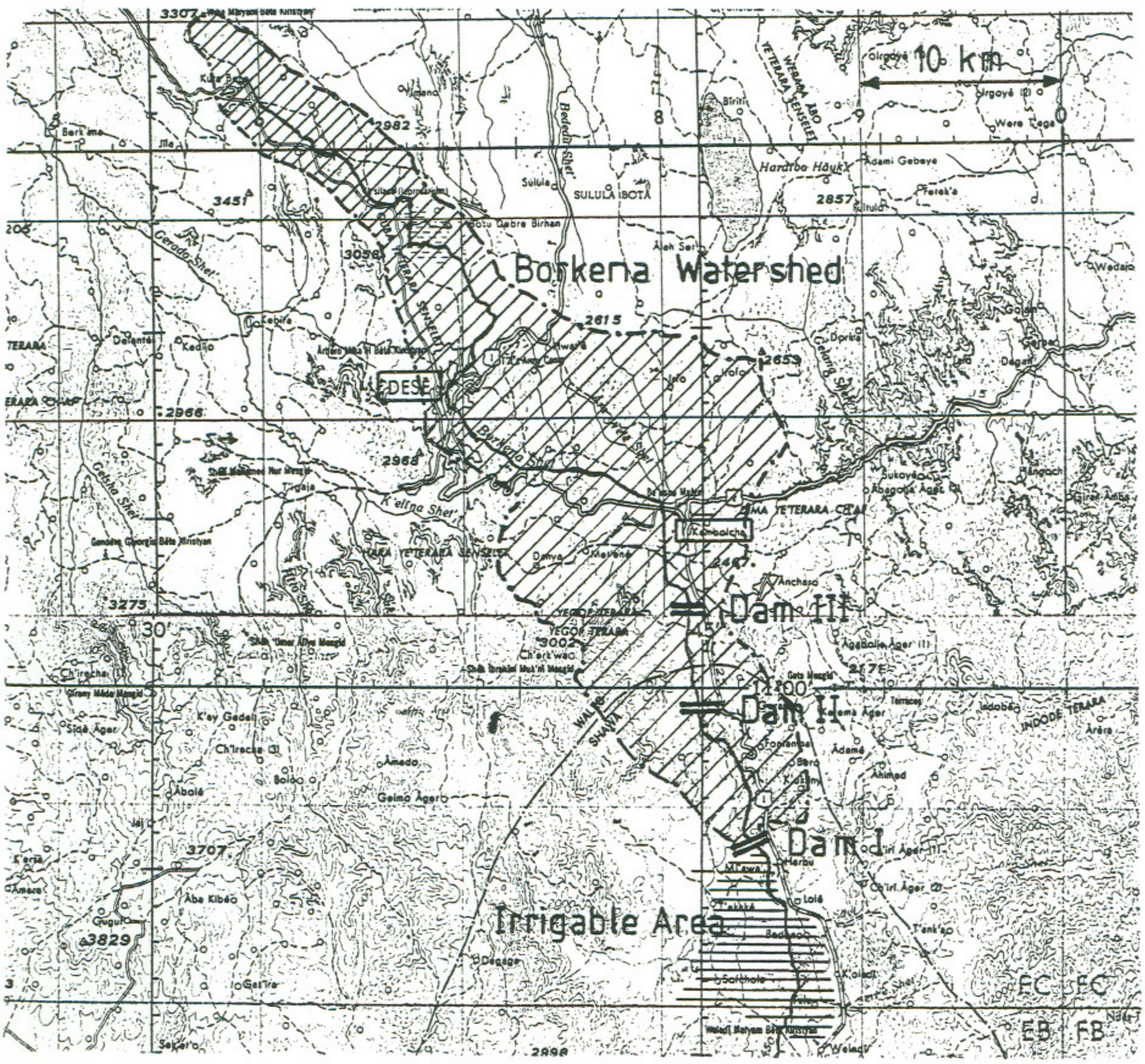


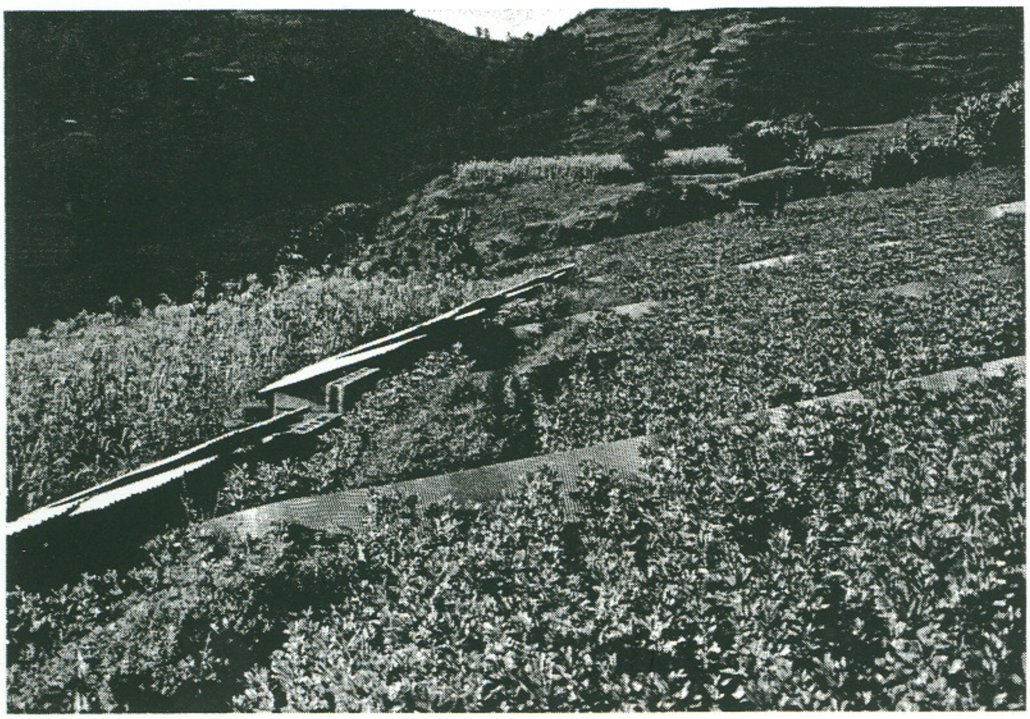

*Figure: Catchment area of the Borkenna dams*

## 3.2. Stops on Wednesday, 22 October 1986

### *(1) Maybar Area (Option 2 Information)*

Maybar area is typical for the eastern escarpment region, situated at medium altitudes between 2500 and 2700 m asl. Having two more or less reliable cropping seasons per year, the area is suitable for a variety of crops, such as wheat, barley, maize (grown over the two rainy seasons) and pulses.

The Maybar area was cultivated for more than 2000 years. Charcoal in sediment deposits, probably originating from deforestation, were dated 2450 years BP (sample B-4325, Hurni, in prep.). As a consequence, the present day soil distribution is the result of a long period of degradation. High accumulations at the foot of the slopes and shallow soils on the hillsides are therefore very typical for the region. See also soil map 1:10'000 of the Maybar area, enclosed with this guide, by Weigel (1986).



*View of conservation experimental plots at Maybar.*

The visit to the Maybar area starts before lunch at point A (see Figure 2) with a walk downslope to the research station of the Soil Conservation Research Project (2 km). Near the station, experimental plots are visited and preliminary results of soil conservation trials presented (see photo). The station operates as one of six distributed in various agro-climatic zones, and was established in 1981. Testplots for soil erosion and runoff measurements (1 to 4) are visited and their monthly data since 1981 presented and interpreted. On the way, two soil profiles, a and b, are opened for inspection and lab results presented here.

After a luncheon picnic at the station, the walk continues through flat land near Lake Maybar where a further soil profile can be seen (c, see Figure 2 and analysis). This lake shore was used during 1985 to initiate an small-scale irrigation programme, with a pump at location B (see Figure 2), and a 2 km channel along the contour (1 % graded) about 40 m above the level of the lake.

After a walk of about 2 km we will take the cars at point B and continue the journey back to the highlands.

*Some Research Results*

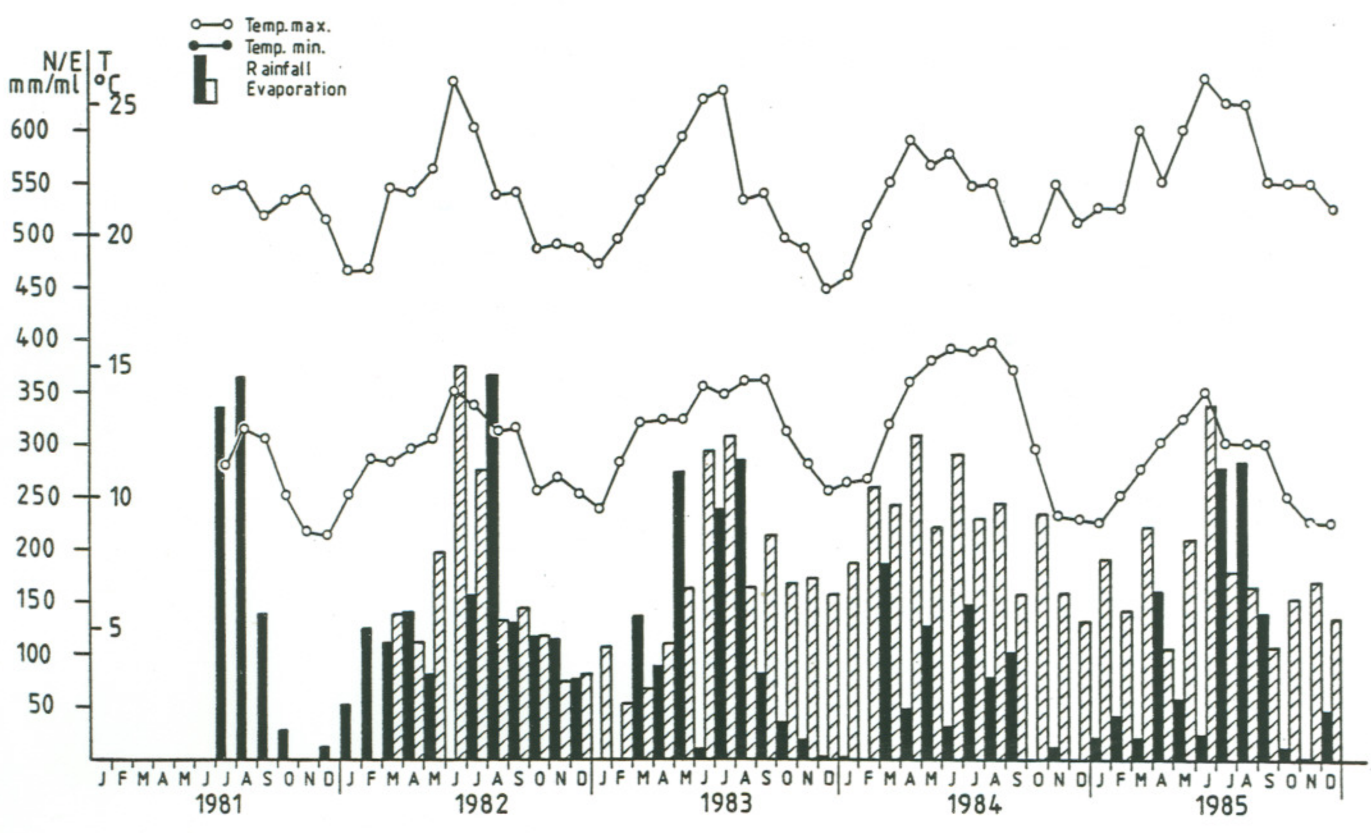



*Figure 1: Climatic data of Abbo Ager, 2500 m asl.*

## MAYBAR AREA

Source: Hans Hurni and Bruno Messerli, 1983: Maybar - Wello Region, 1:10'000. CFSCDD, MoA, Ethiopia

Scale: 1:12820    0    500 m    1 km

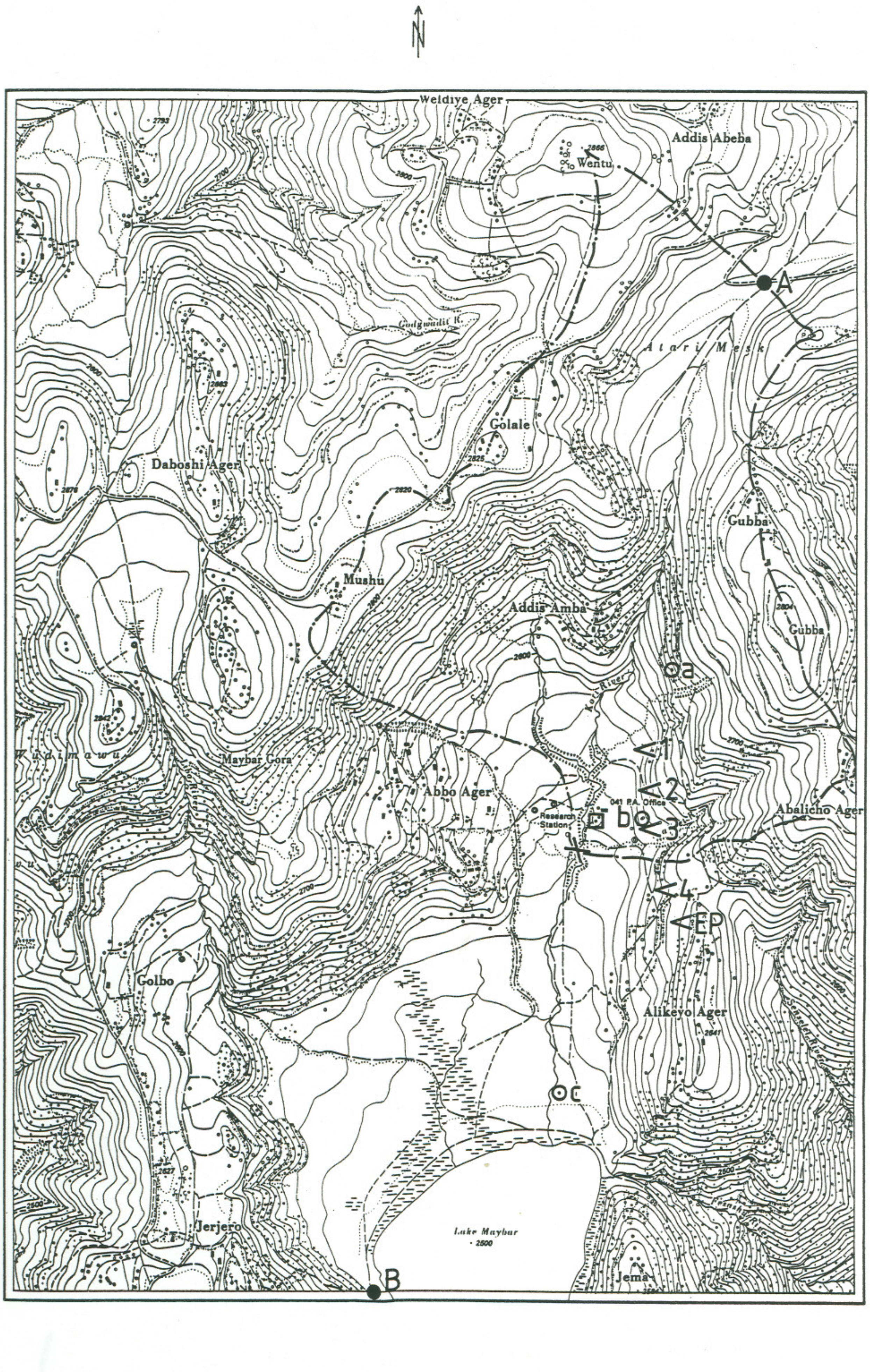
Legend:

| | |
|---|---|
| • 2021 Spot height | Forest (newly planted: P) |
| Local houses | Woodland (afforested: A) |
| Mosque | Bushland |
| Church | Big tree |
| Moslem cementary | Small tree |
| Christian cementary | Gully border |
| Local school | Perennial stream |
| All-weather road | Seasonal stream |
| Dry-weather road | Swampy area |
| Major trail | |
| Local trail | |
| Hedge | |
| Spring | |

Contours are at 10 m vertical intervals, with intermediate 5 m contours if necessary. Elevations in metres.

| | |
|---|---|
| | *Watershed boundary* |
| | *River station* |
| □ | *Research Station SCRP* |
| ⊙a | *Soil profile pits* |
| <3 | *Testplots 2m x 15m* |
| <EP | *Experimental plots 6m x 30m* |
| <FE | *Field-Experiment 0.8 ha* |
| ● A | *Start of walking tour* |
| ● B | *End of walking tour* |

*Figure 2: Map of Maybar area*



N
Weldiye Ager
Addis Abeba
Wentu
2866
2793
2700
2800
A
Godgwadit R.
Atari Mesk
Golale
2825
2820
Daboshi Ager
2863
2876
2600
Gubba
Mushu
Addis Amba
2804
Gubba
a
2942
Wudimawu
Maybar Gora
<1
Abbo Ager
<2
041 P.A. Office
Research Station
b
<3
Abalicho Ager
<4
<EP
Golbo
Alikeyo Ager
2841
c
2627
2500
Jerjero
Lake Maybar
2500
B
Jema

Figure 1 presents monthly summaries of rainfall, evaporation and minimum-maximum temperatures. Clearly emerging is the bimodal rainfall regime with a small rainy season in March-May (Belg in Amharic language) and a big rainy season July-September (Kremt). The drought year 1984 is markedly demonstrated. It seriously affected the agricultural activities in the catchment leading to a crop failure and a famine situation for which the irrigation action provided some relief. Nevertheless, some 60 members of the Peasant Association left the area and joined the resettlement programme in the West of the country.

Figure 3 presents annual summaries of the testplot runoff and soil loss data.

Testplot 1, situated on a 16% slope with a haplic Phaeozem soil, had soil loss between 1.31 mm (maize cultivation, 1983) and 7.5 mm per year (continuous fallow experiment). Much of the 1984 soil loss is the result of a single storm in March 1984.

Testplot 2, situated on a 64% slope with a haplic Phaeozem-Lithosol soil had 4.8 and 9.6 mm during 1981 and 1982 when it was cropped. Later, under grass fallow, the soil loss was reduced to 0.3 mm in 1985.

Testplot 3, situated on a 43% slope with similar soil as Testplot 2, had highest loss in 1983 with 14 mm when it was cropped after some open ploughing time. Grass cover remarkably reduced loss to 1.5 mm in 1985.

Testplot 4, situated on a 37% slope with haplic Phaeozem soil, had normal loss of 1-2 mm per year except for 1984 when the extreme rain storm in March reduced soil depth by 11.8 mm in almost a single storm.

Figure 4 shows severe to moderate limitations of the major soil mapping units in the Maybar area (Weigel, 1986). Serious consequences have to be taken into considerations when carrying out agro-ecological landuse planning. Coupled with population growth, the prospects for the year 2010 look very grim unless integrated and combined actions are not taken immediately. Soil conservation forms one major component of such a programme. Initial measures were implemented in the Kori catchment in 1983.

Figures 5-7 give descriptions and analytical data for the three visited soil profiles a, b and c (Weigel, 1986). The detailed soil map enclosed in the folder at the end of the Guide provides more information on soils which are very shallow in (convex) hillsides and tops, and deep to very deep on the footslopes, where in the vicinity of the lake waterlogging is a serious constraint.

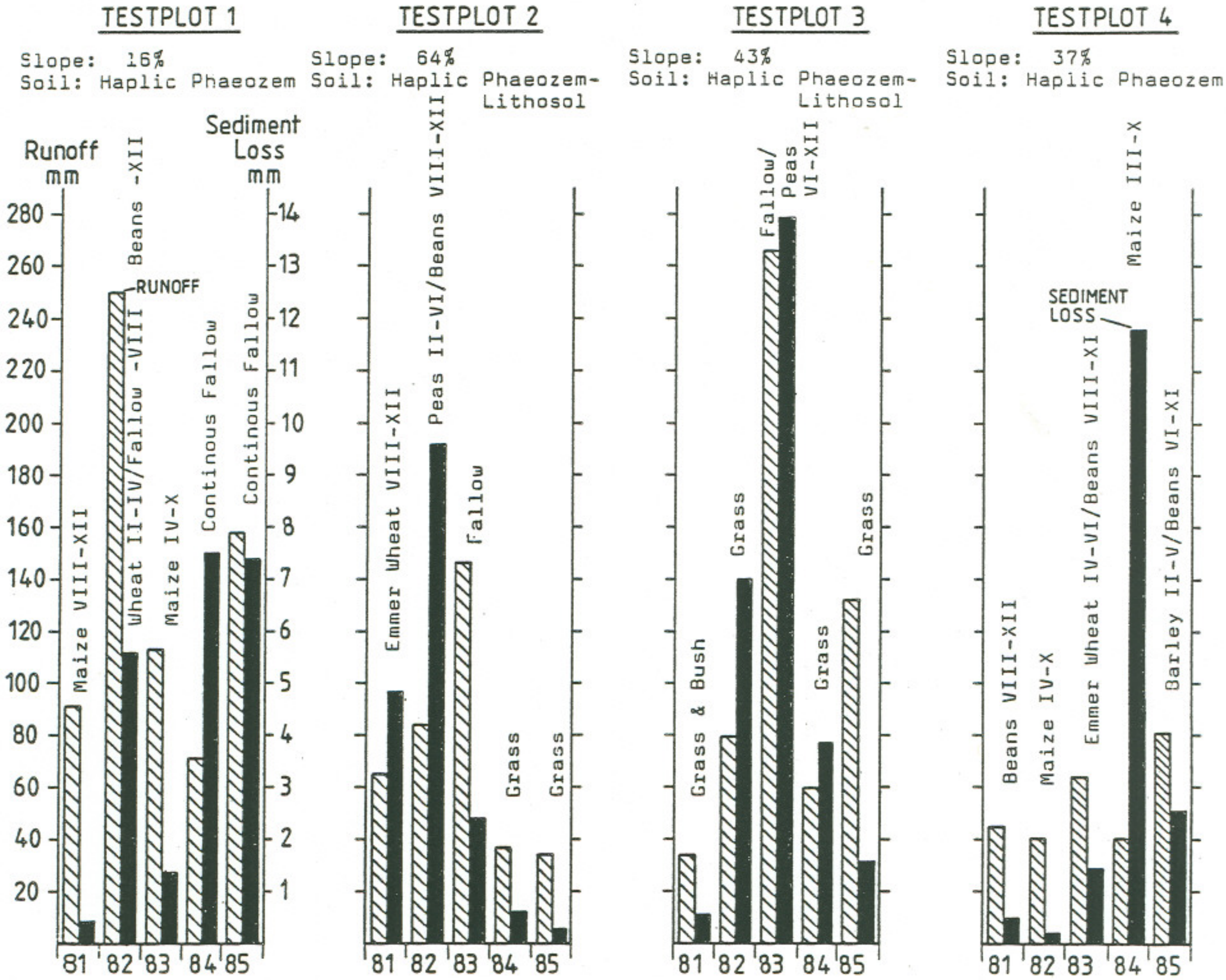



*Figure 3: Annual totals of testplot runoff and soil loss at Abbo Ager Station, Wello Research Unit, SCRP, 1981 - 1985.*

| LMU | | SUITABILITY CLASS | SEVERE LIMITATIONS | | | | | | | | MODERATE LIMITATIONS | | | | | | | | % OF TOTAL AREA | % OF CULTIVATED AREA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | DESIGNATION | | m | d | n | f | r | e | p | s | m | d | n | f | r | e | p | s | | |
| 1 | 2 | 3 | 4a | 4b | 4c | 4d | 4e | 4f | 4g | 4h | 5a | 5b | 5c | 5d | 5e | 5f | 5g | 5h | 6 | 7 |
| 11d | Hh1-I/6 | N2 | | | | | x | X | x | | x | | o | | | | | | 18.63 | 8.53 |
| 11a | Hh1-I/5 | N2 | | | | | x | X | x | | x | | o | | | | | | 16.75 | 17.38 |
| 12d | Hh2-I/6 | N2 | | | | | x | X | x | | o | | x | | | | | | 9.06 | 4.15 |
| 4a1 | Hh3/5 | N1e | | | o | | | x | | | | | | | x | | x | | 6.47 | 9.44 |
| 4d | Hh3/6 | N2 | | | o | | | X | x | | | | | | x | | | | 5.23 | 3.28 |
| 3a1 | Hh2/5 | N2/N1e | | | | | o | X | | | o | | x | | | | x | | 4.91 | 5.92 |
| 5b2 | Hh4/4 | S2n | | | o | | | | | | | | | | | x | | | 4.65 | 7.66 |
| 5b1 | Hh4/4 | S2en | | | | | | | | | | | x | | | x | | | 3.91 | 7.22 |
| 11c | Hh1-I/4 | N2 | | | | | x | | x | | x | | o | | | X | | | 3.50 | 4.81 |
| 12a1 | Hh2-I/5 | N2 | | | | | x | X | | | o | | x | | | | x | | 3.49 | 3.41 |
| 3d | Hh2/6 | N2 | | | | | o | X | x | | o | | x | | | | | | 2.19 | 1.78 |
| 11b | Hh1-I/3 | N2 | | | | | x | | x | | x | | o | | | X | | | 1.80 | 2.57 |
| 4c1 | Hh3/4 | S2n | | | o | | | | | | | | | | x | x | | | 1.58 | 3.11 |
| 5c1 | Hh4/5 | N1e | | | | | | x | | | | | x | | | | | | 1.43 | 2.79 |
| 3c | Hh2/4 | N1r/S2r | | | | | o | | | | o | | x | | | x | x | | 1.42 | 1.63 |
| 7a | Je/4 | N1s | | | | | | | | x | | | x | o | | x | | | 1.31 | 0.96 |
| 12c | Hh2-I/4 | S2r/N1r/N2 | | | | | x | | | | o | | x | | | X | x | | 1.28 | 1.48 |
| 9a | Gm1/3 | N1d | | x | o | | x | | | | | | | | | x | | | 1.19 | 0.39 |
| 4c2 | Hh3/4 | S2np | | | o | | | | o | | | | | | x | x | | | 1.00 | 1.92 |
| 5a1 | Hh4/3 | S2en | | | | | | | | | | | x | | | x | | | 0.95 | 1.67 |

Explanations:

Column 1:

LMU = land mapping unit. Every LMU in the agroecological development plan (Fig. 9, Chapter 4.2) or the land suitability map (Fig. 6) is marked by a number, e.g. "1a". A land mapping unit may consist of several separate subunits with the same LMU No.

Column 2:

The designation of a LMU consists of two parts, the first one indicating the soil mapping unit (e.g. Hh2) and the second one representing the slope class (definition of the slope classes see Table 3, Chapter 3.2). List of the soil mapping units: Hh1-I = Haplic Phaeozems, very shallow, associated with Lithosols: Hh2-I = Haplic Phaeozems, associated with Lithosols: Hh2 = Haplic Phaeozems, shallow: Hh3 = Haplic Phaeozems, moderately deep to deep: Hh4 = Haplic Phaeozems, very deep: Je = Eutric Fluvisols: Re = eutric Regosols: Gm1/Gm2 = Mollic Gleysols.

Column 3:

Suitability classes:
S2: moderately to marginally suitable (with lower-case letters indicating the dominant limitation, see column 4)
N1: currently not suitable (with lower-case letters indicating the dominant limitation)
N2: permanently not suitable

If two suitability classes are indicated, the first one refers to maize, the second one to barley; for balances and summaries the better of the two suitability classes was taken: in the LMU 12b and 12c there are 3 suitability classes, the first two indicating the suitability for maize and barley on the deeper soils (60 % of the LMU), the third one indicating the suitability for maize and barley on the very shallow soils.

Columns 4a-5h:

The limitations are divided into two groups:
a) severe limitations: These limitations require a classification as "not suitable"
b) moderate limitation: These limitations prevent a classification as "highly suitable", but the land is still "moderately to marginally" suitable, plant growth is somewhat reduced and/or a moderate soil degradation takes place.

The kind of limitations are indicated as follows:

| column No. | symbol | designation |
|---|---|---|
| 4a,5a | m | moisture availability |
| 4b,5b | d | drainage |
| 4c,5c | n | nutrient deficiency |
| 4d,5d | f | flooding |
| 4e,5e | r | rooting conditions |
| 4f,5f | e | erosion |
| 4g,5g | p | land preparation workability |
| 4h,5h | s | specific problems |

The limitations of every LMU are indicated by means of 3 different symbols, expressing the degree of limitation:
X = strong
x = moderate
o = slight (except nutrient deficiency "n": if only phosphorus is limiting, the symbol "o" is applied, although this limitation may be strong; however, statements on the phosphorus supply are too problematic to be decisively involved in the suitability classification, see Chapter 2.2.4).

Column 6:

Total area of all subunits with the same LMU number in % of the total study area.

Column 7:

Cultivated area of the LMU in % of the total cultivated land in the study area. On the "extensively cultivated" area, on an average, one year of cultivation is followed by 3 years of fallow. Therefore, it was assumed that, on a long term, 1/4 of the "extensively cultivated" area is cultivated, whereas 3/4 are not cultivated. The sum of the "permanently cultivated" area, plus 1/4 of the "extensively cultivated" area, is considered as "cultivated area".

*Figure 4: Land suitability classification in Maybar before soil conservation (90% of classified area). Weigel, 1986.*

## Legend for Figures 5, 6 and 7:

Organic matter content:

- <1 % organic matter
- 1 - 2 % organic matter
- 2 - 5 % organic matter
- 5 -10 % organic matter

Gravel, stones, rock:

- gravel, stones (solid)
- gravel, stones (well weathered)
- rock (solid)
- rock (well weathered)

Further aspects:

- iron manganese nodules and concretions
- iron mottles
- charcoal
- big termite burrows, krotowinas
- small termite burrows, worm casts etc.
- roots
- tree roots

## Legend for the diagrams

Texture:

- clay (< 2μ)
- silt (2 - 20μ)
- sand (20 - 2000μ)

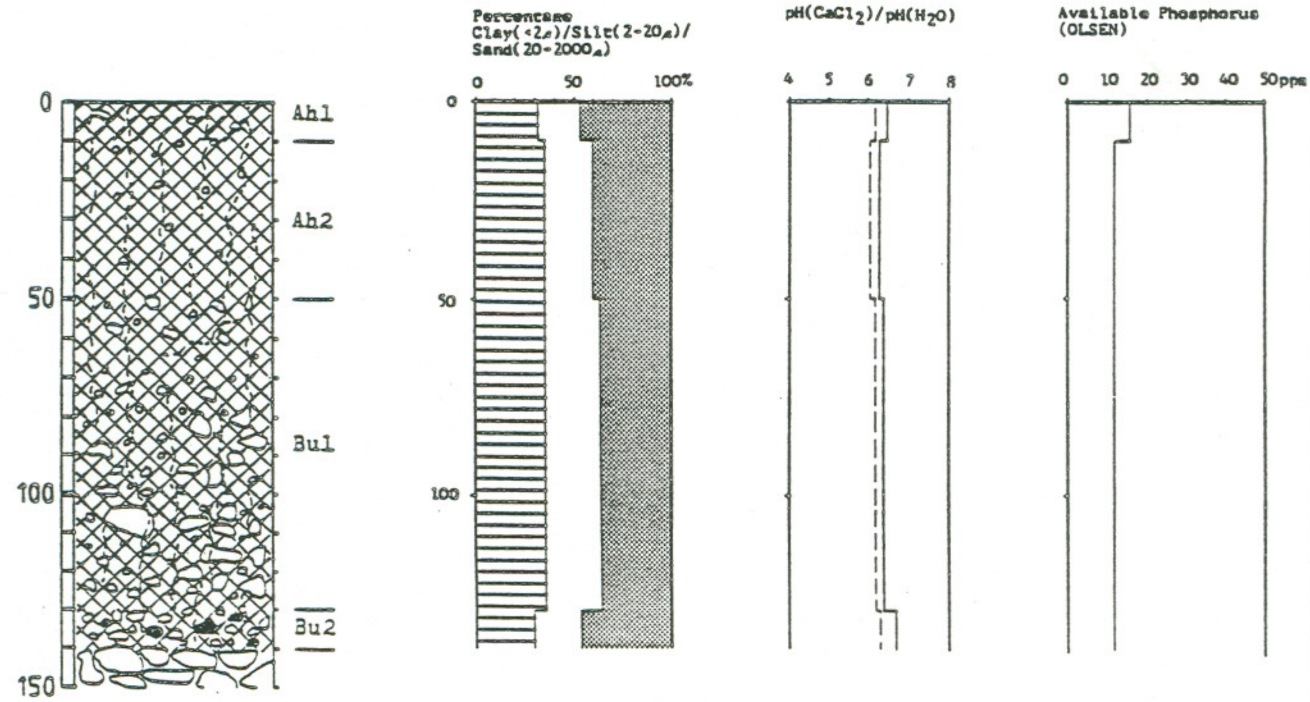
pH:

- pH ($CaCl_2$)
- pH ($H_2O$)

*Figure 5: Soil profile location a in Maybar (Weigel 1986).*

## a Haplic Phaeozem

| | | | |
|---|---|---|---|
| Location: | Maybar/Wello 571.980/1215.995 | Slope class (FAO 1977): | 6 |
| Date of description: | 29.5.83 | Land use/vegetation: | woodland: 40 % Juniperus trees, 30 % shrubs (mainly Juniperus), 30 % pasture; the profile is situated under a very old Juniperus tree |
| Elevation: | 2640 m | | |
| Aspect: | W | | |
| Position of profile: | very steep, linear slope | Surface stoniness: | fairly stony, some boulders |
| | | Drainage class (FAO 1977): | 4 |
| | | Soil depth: | very deep (140 cm) |




Ah1 dark brown (7.5 YR 3/2) moist and brown (7.5 YR 5/3) dry, sandy clay loam, slightly gravelly (8 vol. %); moderate fine to medium crumb; slightly sticky and slightly plastic wet, friable moist; many pores; frequent very fine to coarse roots; clear smooth boundary.

Ah2 dark brown (7.5 YR 3/2.5) moist and brown (7.5 YR 5/3) dry, clay loam, slightly gravelly (8 vol. %) moderate medium subangular blocky; slightly sticky and slightly plastic wet, friable moist; common pores; frequent very fine to coarse roots;

Bu1 dark brown (10 YR 3/3) moist and brown (7.5 YR 5/2) dry, clay loam, gravelly (19 vol. %) and stony; moderate fine crumb to subangular blocky; slightly sticky and slightly plastic wet, friable moist; common macropores, many biopores; frequent very fine to coarse roots; clear wavy boundary.

Bu2 black to very dark brown (10 YR 2/1.5) moist and brown to dark brown (7.5 YR 4/2) dry, sandy clay loam, gravelly (31 vol. %) and stony; moderate fine crumb to subangular blocky; sticky and slightly plastic wet, friable moist; common pores; common very fine to coarse roots; many charcoal pieces.

| Depth (cm) | Horizon | Bulk Density ($g/cm^3$) | Pore Volume (%) | pH ($H_2O$) | pH ($CaCl_2$) | Organic Matter (%) | Total N (%) | C/N | Exchangeable Cations (me/100g soil) Na | K | Ca | Mg | Sum | Available P (OLSEN) ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0- 10 | Ah1 | | | 6.5 | 6.2 | 5.0 | 0.22 | 13 | 0.31 | 1.06 | 38.50 | 10.01 | 49.88 | 16 |
| 10- 50 | Ah2 | | | 6.3 | | 3.7 | 0.17 | 13 | 0.29 | 0.50 | 35.53 | 10.05 | 46.37 | 12 |
| 50-130 | Bu1 | | | 6.4 | 6.2 | 4.7 | | | 0.41 | 0.49 | 42.83 | 8.17 | 51.90 | 12 |
| 130-140 | Bu2 | | | 6.7 | 6.3 | 4.8 | | | | | | | | 12 |

*Figure 6: Soil profile of location b in Maybar (Weigel, 1986).*

## b Haplic Phaeozem, stony phase

Location: Maybar/Wello 571.400/1215.600 (Testplot 3 S.C.R.P.)

Date of description: 21.11.82

Elevation: 2560 m

Aspect: SW

Position of profile: steep convex slope

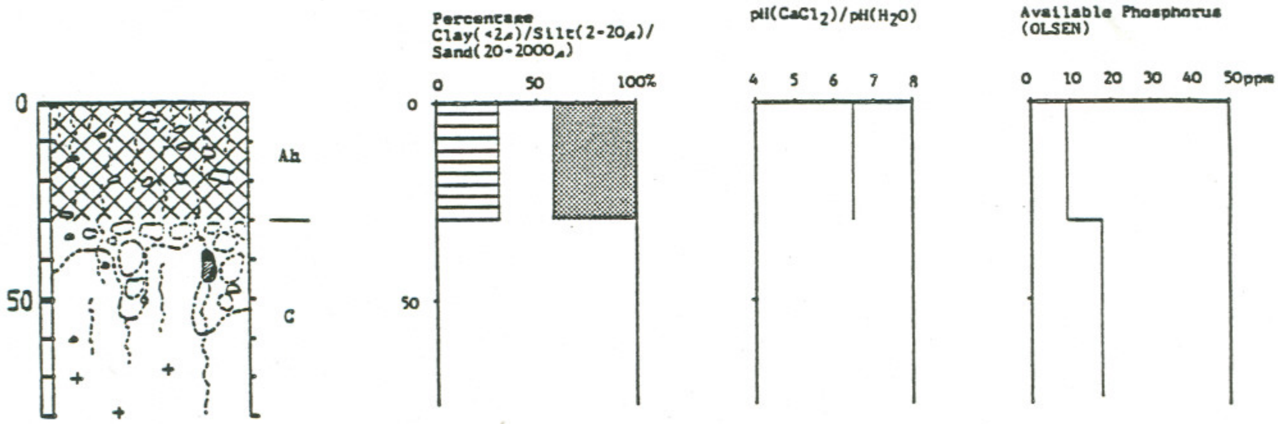
Slope class (FAO 1977): 5

Land use/vegetation: fallow/grass

Surface stoniness: fairly stony

Drainage class (FAO 1977): 4-5

Soil depth: moderately deep (75 cm)




Ah dark brown (7.5 YR 3/2) moist and brown to dark brown (7.5 YR 4/3) dry, clay loam, slightly gravelly (6 vol. %); moderate fine crumb; very friable moist; very frequent fine roots, abrupt smooth boundary.

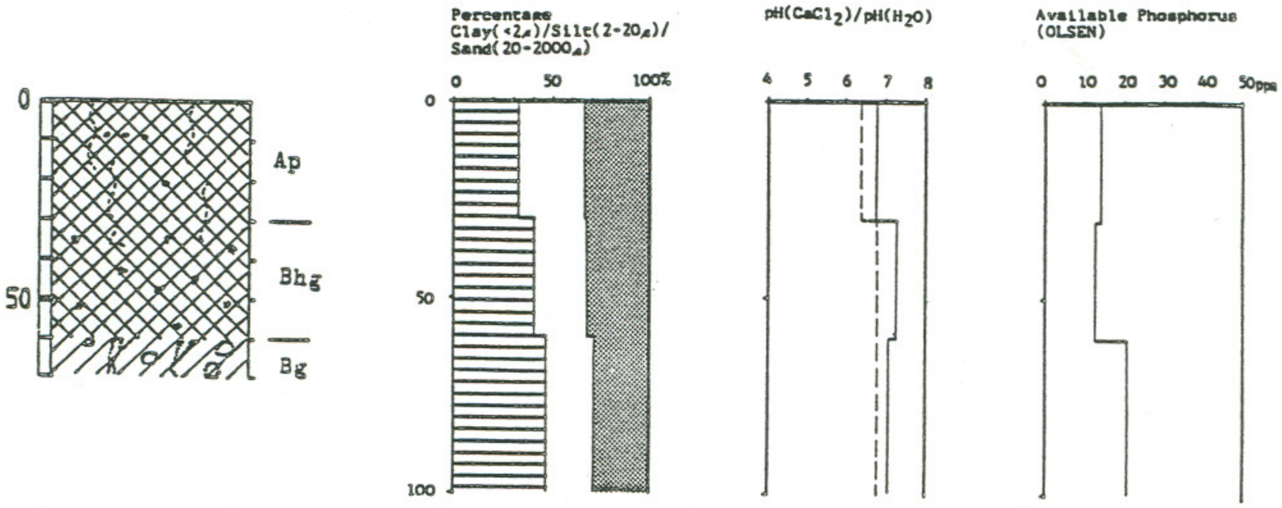
C very dark gray (5 YR 3/1) moist, highly weathered rock, soft to moderately hard , common fine roots down to 75 cm.

| Depth (cm) | Horizon | Bulk Density (g/cm³) | Pore Volume (%) | pH ($H_2O$) | pH ($CaCl_2$) | Organic Matter (%) | Total N (%) | C/N | Exchangeable Cations (me/100g soil) Na | K | Ca | Mg | Sum | Available P (OLSEN) ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0- 30 | Ah | 0.94 | | 6.5 | | 3.4 | 0.15 | 13 | 0.05 | 0.53 | 31.01 | 11.22 | 42.81 | 9 |
| 30- 75 | C | | | | | | | | | | | | | 18 |

*Figure 7: Soil profile of location c in Maybar (Weigel, 1986).*

# C Mollic Gleysol

| | | | |
|---|---|---|---|
| Location: | Maybar/Wello 571.750/1215.000 | Slope class (FAO 1977): | 1 |
| Date of description: | 21.11.82 | Land use/vegation: | arable land (maize) |
| Elevation: | 2505 m | Surface stoniness: | stony |
| Aspect: | SW | Drainage class (FAO 1977): | 2 |
| Position of profile: | almost flat, valley bottom, flood plain | Soil depth: | shallow (~40 cm; due to hig water table) |




| | |
|---|---|
| Ap | dark brown (7.5 YR 3/2) moist and brown (7.5 YR 5/3) dry, clay loam, slightly gravelly (3 vol. %); weak fine to medium subangular blocky; sticky, firm moist, hard to very hard dry; few macropores; few fine roots; clear, smooth boundary. |
| Bhg | dark brown (7.5 YR 3/2) moist and brown (7.5 YR 5/3) dry, clay; moderate fine to medium subangular blocky; firm moist; few macropores; very few fine roots; broken, thin clay skins; very few small iron concretions; clear smooth boundary. |
| Bg | dark brown (7.5 YR 3/4) moist and brown (7.5 YR 5/3) dry, clay; weak medium angular blocky (nearly massive); sticky, slightly plastic wet; very few macropores; no roots; many medium faint to distinct, dark brown to brown (7.5 YR 4/2) mottles; |

groundwatertable on 21.11.82: in 75 cm depth, after 1 1/2 hours in 70 cm depth.

| Depth (cm) | Horizon | Bulk Density (g/cm$^3$) | Pore Volume (%) | pH ($H_2O$) | pH ($CaCl_2$) | Organic Matter (%) | Total N (%) | C/N | Exchangeable Cations (me/100g soil) Na | K | Ca | Mg | Sum | Available P (OLSEN) ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0- 30 | Ap | 1.01 | | 6.8 | 6.4 | 2.? | 0.12 | 14 | 0.22 | 0.32 | 37.80 | 13.29 | 51.63 | 14 |
| 30- 60 | Bhg | 0.89 | | 7.3 | 6.8 | 3.1 | 0.15 | 12 | 0.42 | 0.25 | 41.24 | 15.56 | 57.47 | 13 |
| 60-100 | Bg | | | 7.1 | 6.8 | 1.9 | | | | | | | | 21 |

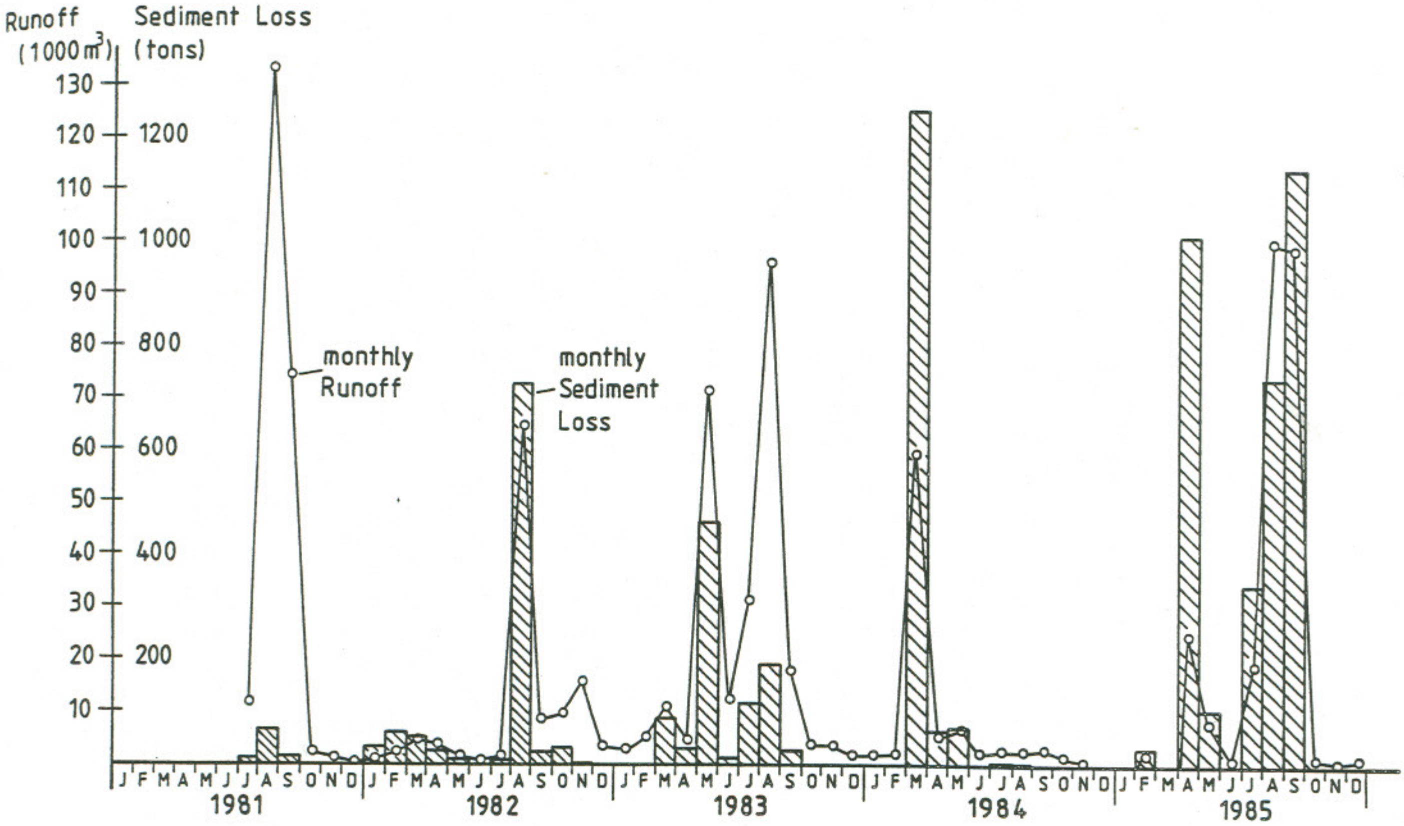



*Figure 8: Monthly runoff and suspended sediment loss of the Kori river in Maybar, 1981 to 1986.*

Figure 8 presents monthly runoff and sediment loss values for the Kori catchment (see delimitation in Figure 2). Out of the 116 hectares, about 40% are cultivated land, 10% fallow land and the remaining 50% grass, bush or forest land. Villages occupy a minor part of the catchment. Values in Figure 8 are indicative because a correct discharge rating curve was established and used only for 1985 while previous years were analysed with a preliminary curve.

*Sources of Information:*


Hurni, H, in prep.: Soil erosion and conservation in Ethiopia.

Weigel, G., 1986: The soils of the Maybar area. SCRP Research Report 7, 104 pp.

Weigel, G., 1986: An agroecological development plan for the Maybar area. SCRP Research Report 9, 78 pp.

SCRP, var. years: Annual Progress Reports with summaries of annual research data. SCRP, Addis Abeba.

## 3.3. Stops on Thursday, 23 October 1986

### *(1) Kemise Market*

Kemise is a fast growing small town and it is the administrative centre of Isseye Golla District in the Kalu Province of Wello Administrative Region.

Kemise is situated in the Borkena Valley and has an altitude of about 1450m asl. It provides an excellent example of the interdependence of and interaction between mountains and lowlands. To the west of it and across the Borkena are the massive mountains of Menz-Gishe and of Albukko. To the east a narrow mountain chain runs north-south, rising to barely 2500m asl and sufficient to obstruct a view of the Awash Valley further east. All these forms the catchment, as it were, of the Kemise Market.

The Thursday Market in Kemise shows a large variety of agricultural and artisan products. At Kemise different economies find a ready outlet. But what makes the market even more picturesque is the coming together of various linguistic groups (Amharic, Oromigna and Afarigna speakers), of various religious groups (Christians and Muslims), and of peasant cultivators, nomadic pastoralists and townspeople.

## *(2) Hulet Wenz Area (Option 2 Information)*

The Hulet Wenz catchment is typical of the degraded highlands of Ethiopia, which have altitudes between about 3000 and 3700 m asl. In this altitudinal belt, only barley can be grown as main crop, except potatoes in some regions. Degradation is high due to a long history of landuse and due to high rainfall.

The location of Andit Tid Station of the Soil Conservation Research Project is on the road from Debre Birhan to Debre Sina. (See land cover map attached in folder. The Hulet Wenz catchment is situated southeast of the road between Gudo Beret and Koso, see land cover map of Erni, 1986 in folder).

In the main rainy season (July 1982), data collection started with river runoff and sediment yield measurements. At the same time the buildings were constructed. In 1983, testplots were set up, and monitoring of runoff and soil loss from these plots was started.

At the turn of the year 1983/1984, soil conservation was implemented through the CFSCDD, using a proposal made by SCRP (see photos p.46). The measures implemented differ from the ones surrounding the station. They are graded for drainage and consist of a type typical for Kenya: Fanya juu or "Throw uphill" measures where the ditch is below the bund. Graded structures are considered more suitable for high rainfall areas, e.g. for the highlands. The Research Unit monitors the ecological results of this new experimentation in Ethiopia. Already now, increases in production can be visibly observed as shown in the photo. For soil fertility improvements, a soil burning system called "gai" is applied traditionally (see photo p. 16).

The visit to the Hulet Wenz area starts after lunch at point A (see Figure 1) with a walk slightly upslope to the upper catchment. Soils are little disturbed there as seen in Figure 2, whereas more downstream they are much reduced as seen in Figure 3 (profile descriptions from Bono and Seiler, 1984). Soil distribution and degree of degradation is shown in the map enclosed in the folder.

The highlands are important for grass and livestock production. Afro-alpine vegetation is still preserved in parts of the Hulet Wenz catchment.

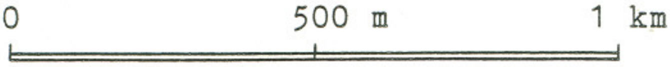
After crossing Wadyat, one of the two valleys belonging to the Hulet Wenz catchment a highland settlement, Wani Gedel, is visited at 3400 m asl and local inhabitants contacted for discussion.

Finally, the research station is reached after descending down to 3100 m asl (point B on Figure 1) where data collected are discussed.

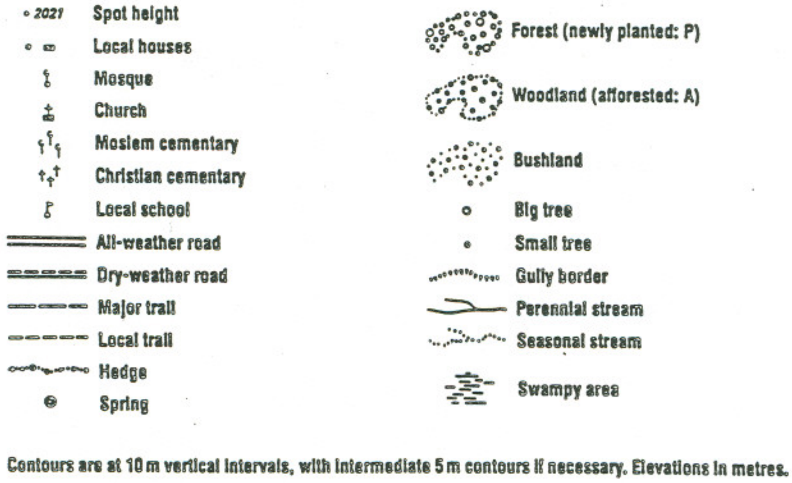
## Hulet Wenz Area

Source: Hans Hurni and Bruno Messerli, 1983: Andit Tid - Shewa Region, 1:10'000. CFSCDD, MoA, Ethiopia

Scale: 1:12820




Legend:



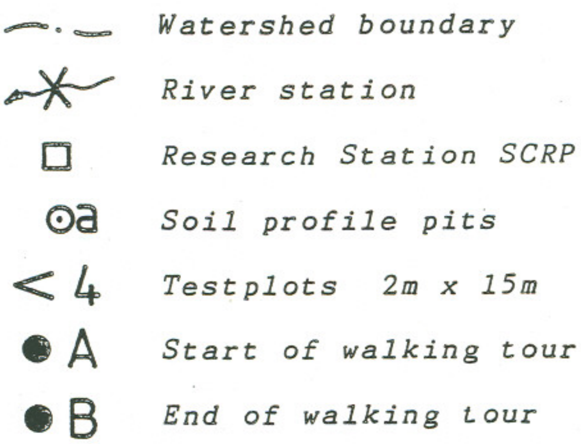
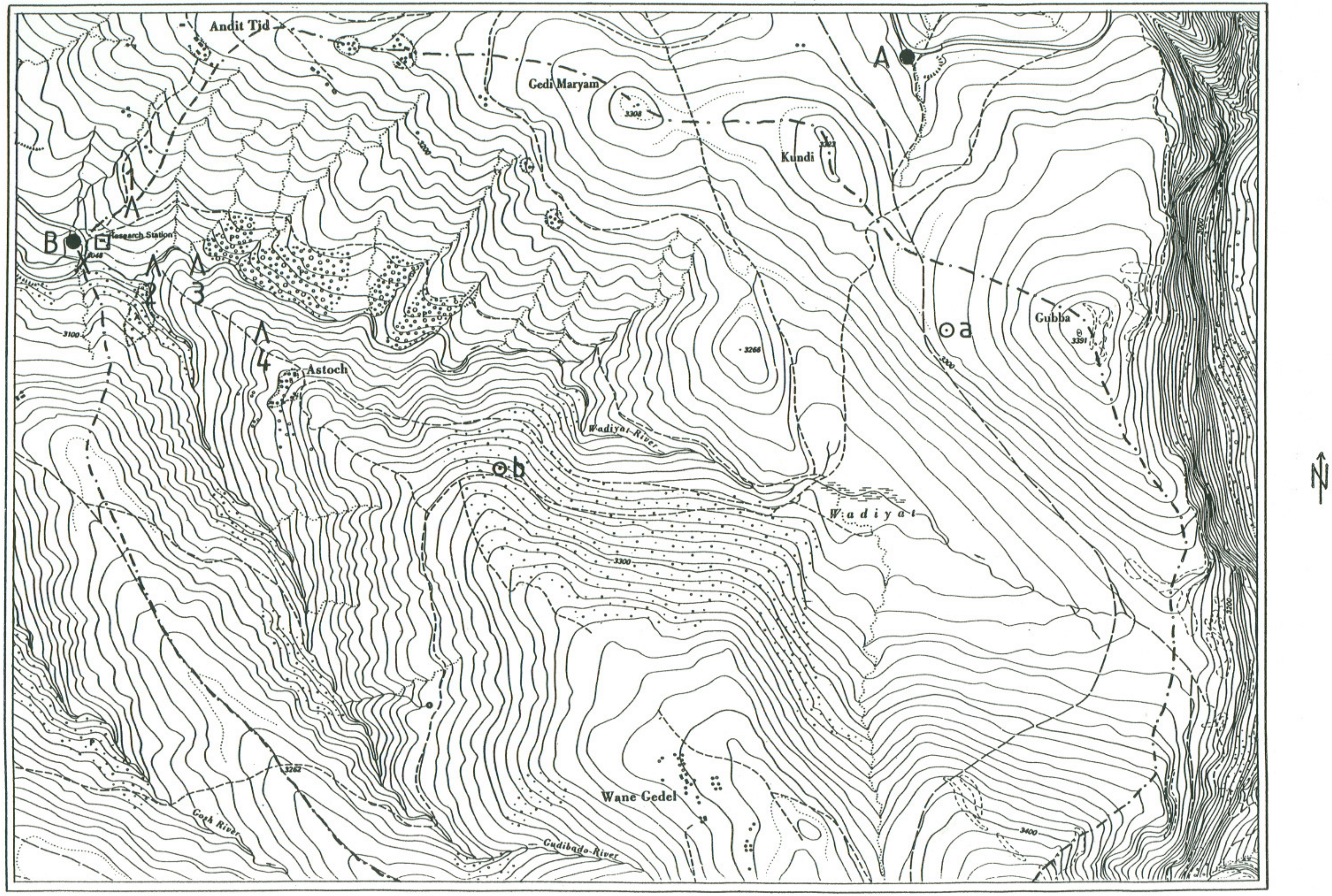




*Figure 1: Map of Andit Tid (Hulet Wenz) area*


Andit Tid
A
Gedi Maryam
3308
Kundi
3323
Gubba
3391
B
Research Station
3048
1
2
3
4
Astoch
3266
a
b
Wadiyat-River
W a d i y a t
3300
3100
3262
Wane Gedel
Gosh River
Gudibado-River
3400
N

*Graded "Fanya juu" conservation measures implemented near Wani Gedel in the Hulet Wenz catchment in December 1983 (Option 2).*

*Conservation through "Food-for-Work" programmes always attracts many people willing to do such works.*

Legend for Figures 2 and 3:

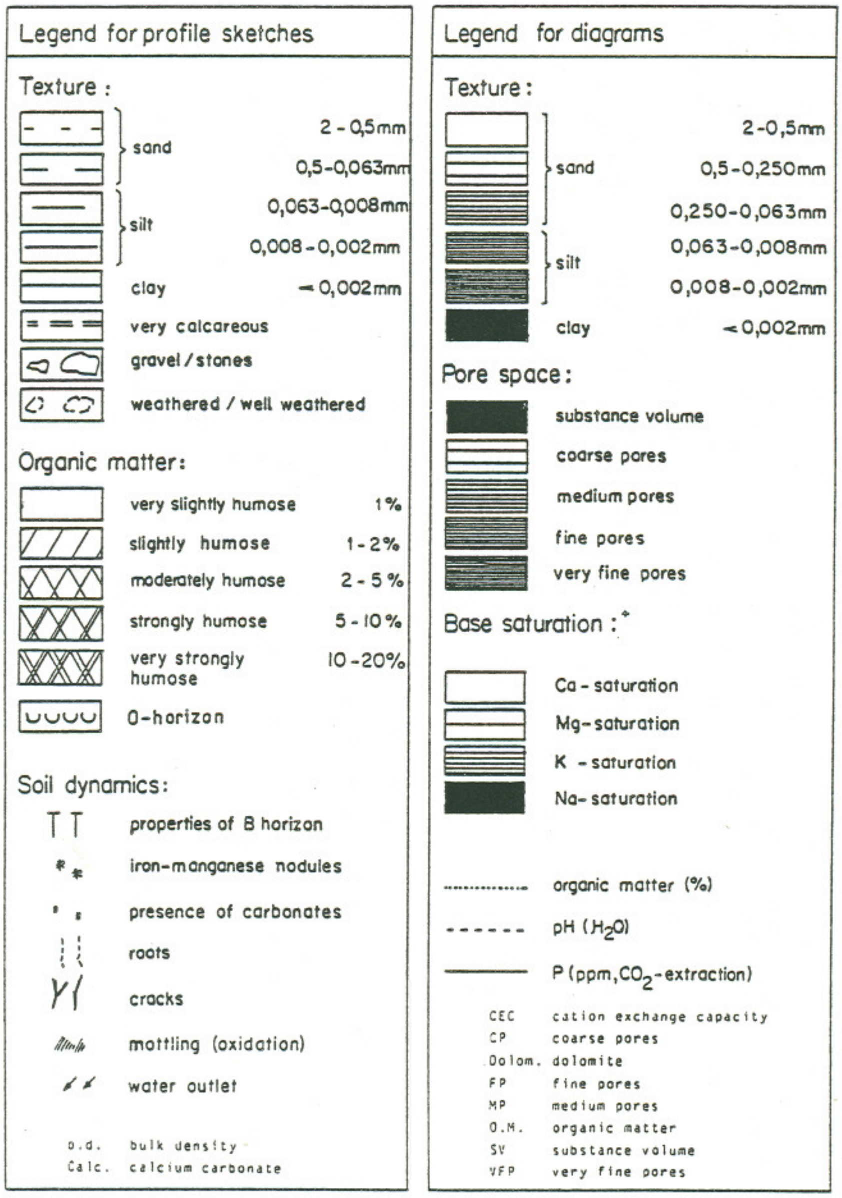
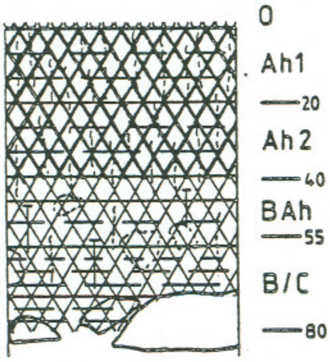


*Figure 2: Soil profile at location a in the Hulet Wenz catchment (Bono and Seiler, 1984).*

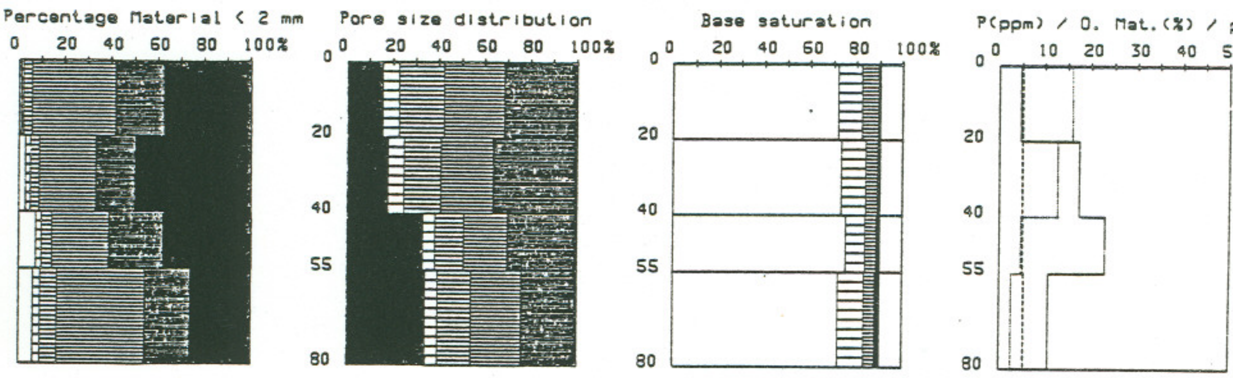
| a | humic Andosol |
|---|---|

| | |
|---|---|
| Position of profile: | depression on a slope, concave |
| Slope gradient: | strongly sloping (10 %) |
| Land-use: | pasture |
| Surface stoniness: | very stony, few rock outcrops |
| Drainage class: | 5 |
| Soil depth: | moderately deep (70-80 cm) |

Location: 579.880/1082.820
Elevation: 3415 m
Aspect: N.




| | |
|---|---|
| Ah1<br>Ah2 | 0-40 cm depth: black (10 YR 2/1) moist; silty clay loam and silty clay; weak medium crumb; friable moist; many fine and medium pores; very frequent fine roots; very few gravel, fresh; clear, smooth boundary; on the surface a small organic horizon (1-2 cm) can be observed; no sample taken; |
| BAh | dark brown (7,5 YR 3/2) moist; silty clay loam; weak fine subangular blocky; friable moist; many fine and medium pores; few fine roots, no medium or coarse roots observed; frequent fine and coarse gravel, strongly weathered; clear, wavy boundary; |
| B/C | brown and dark brown (10 YR 4/4) moist; silt loam; weak fine subangular blocky; friable moist; common fine and medium pores; few fine roots; frequent coarse gravel and stones, strongly weathered; clear, broken boundary; few thin clay skin; below 80 cm fresh stones and boulders, rounded at edges; no sample taken; |



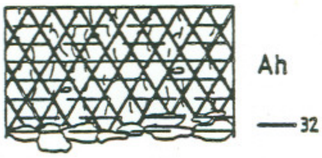

| Depth | Horizon | b.d. | SV | Pore Space (%) | | | | pH | O.M. | N | C/N | Calc. | Dolom. | CEC | Base S. | Ca | Mg | K | Na | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| cm | | g/cm3 | % | CP | MP | FP | UFP | H2O | % | % | | % | % | mval | % | ppm | ppm | ppm | ppm | ppm |
| 20 | Ah1 | .67 | 16 | 7 | 20 | 26 | 32 | 5.0 | 16.0 | .62 | 15.0 | | | | | 3356 | 486 | 336 | 28 | 4.6 |
| 40 | Ah2 | .67 | 18 | 7 | 16 | 22 | 37 | 4.9 | 12.8 | .21 | 35.4 | | | | | 2047 | 293 | 142 | 30 | 17.4 |
| 55 | BAh | | | | | | | 5.0 | 4.5 | .22 | 12.0 | | | | | 1280 | 142 | 82 | 26 | 22.9 |
| 80 | B/C | .99 | 34 | 5 | 15 | 22 | 24 | 5.3 | 2.6 | .10 | 14.9 | | | | | 1170 | 185 | 78 | 34 | 10.7 |

*Figure 3: Soil profile at location b in the Hulet Wenz catchment (Bono and Seiler, 1984).*

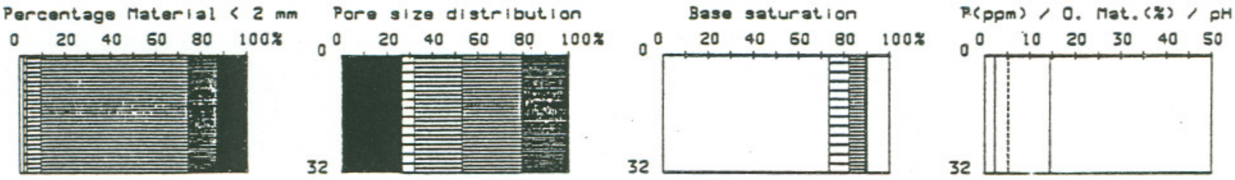
| b | shallow, stony, humic Andosol |
|---|---|

| | |
|---|---|
| Position of profile: | convex slope (sporn) |
| Slope gradient: | - |
| Land-use: | heather |
| Surface stoniness: | exceedingly stony |
| Drainage class: | 5 |
| Soil depth: | shallow (32 cm) |

Location: 578.950/1084.290
Elevation: 3250 m
Aspect: NNE




Ah black (5 YR 2.5/1) moist; silt; common fine granular; friable moist; high pore volume; very frequent fine roots;




| Depth | Horizon | b.d. | SV | Pore Space (%) | | | | pH | O.M. | N | C/N | Calc. | Dolom. | CEC | Base S. | Ca | Mg | K | Na | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| cm | | g/cm3 | % | CP | MP | FP | UFP | H2O | % | % | | % | % | mval | % | ppm | ppm | ppm | ppm | ppm |
| 32 | Ah | .97 | 27 | 6 | 21 | 26 | 21 | 5.3 | 4.6 | .79 | 10.7 | | | 24.3 | 82.4 | 3680 | 438 | 342 | 44 | 2.3 |

*Improved moisture due to "Fanya juu" graded bunding is shown by the green matter (dark colour) of barley behind the bund, while the upslope crop is already dry.*

*Testplot 1 at Andit Tid Station of SCRP in the Hulet Wenz catchment set up to monitor runoff and soil loss as well as production on this traditionally managed field.*

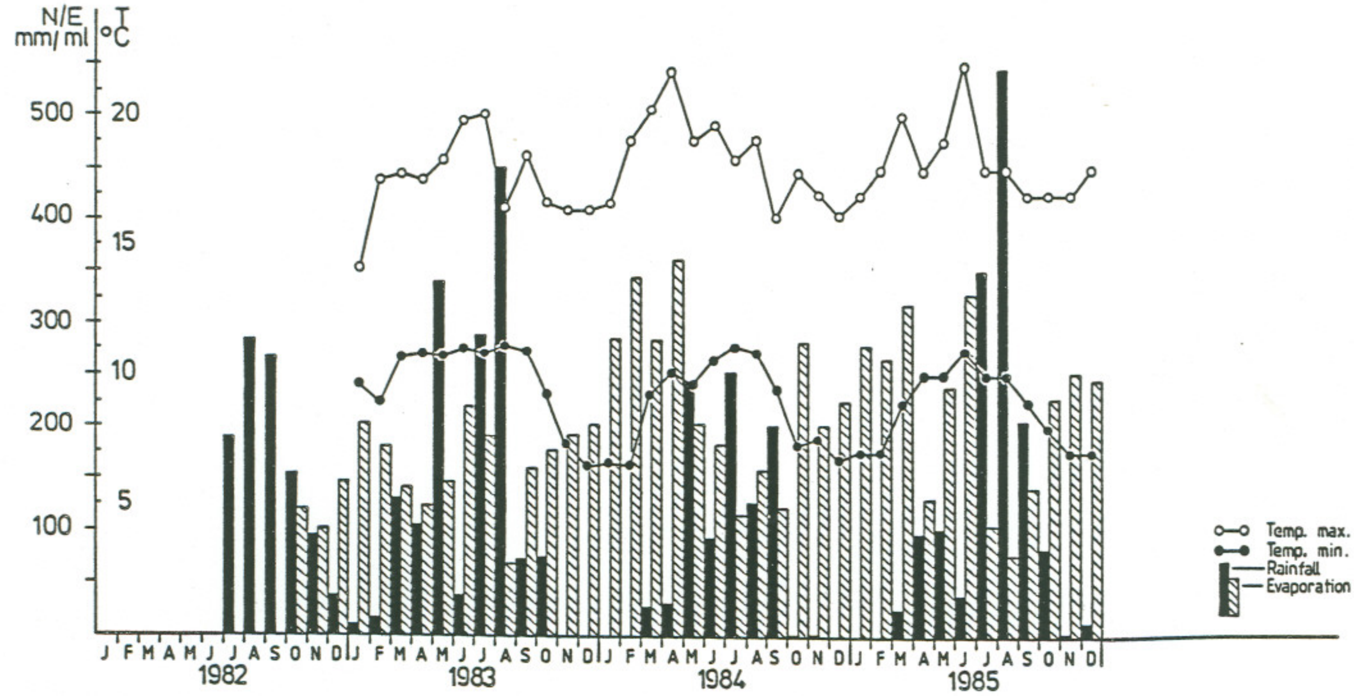



*Figure 4: Summary of climatic data for Andit Tid Station*

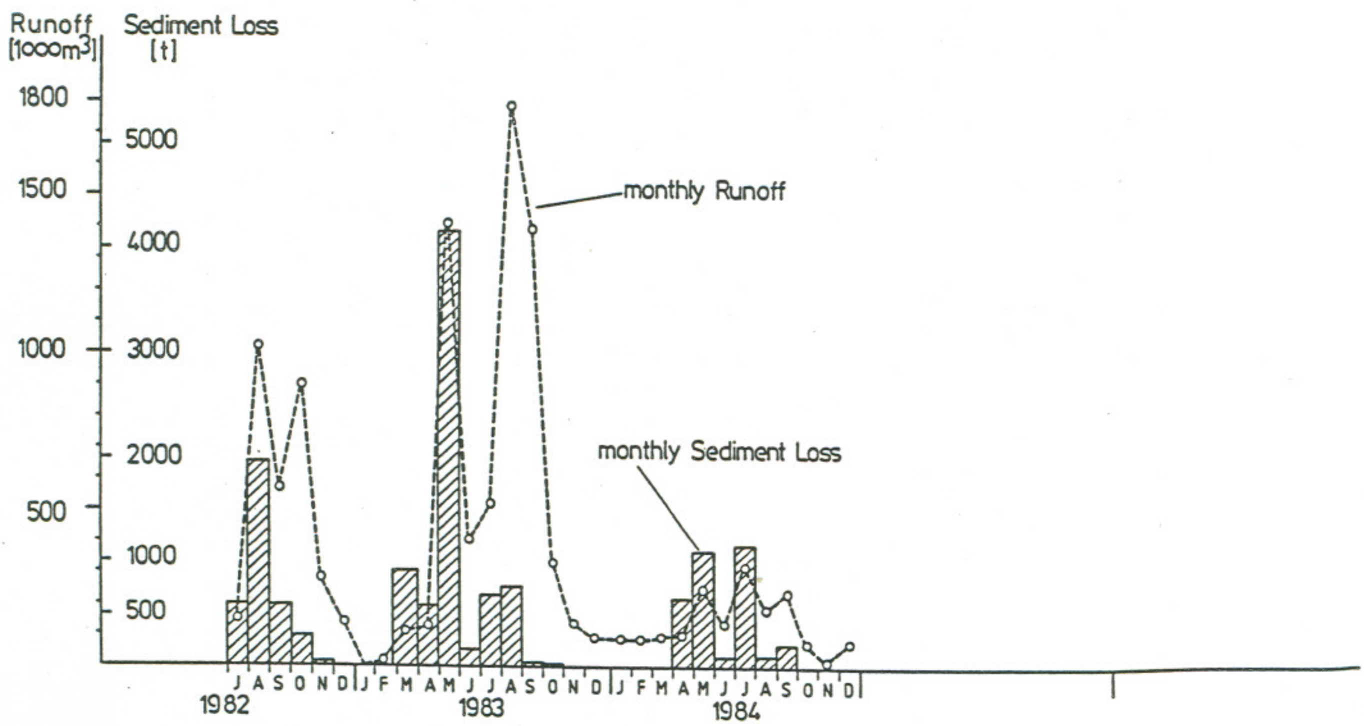



*Figure 5: Runoff and suspended sediment loss data of the Hulet Wenz catchment, Shewa Research Unit, SCRP.*

*Some Research Results*

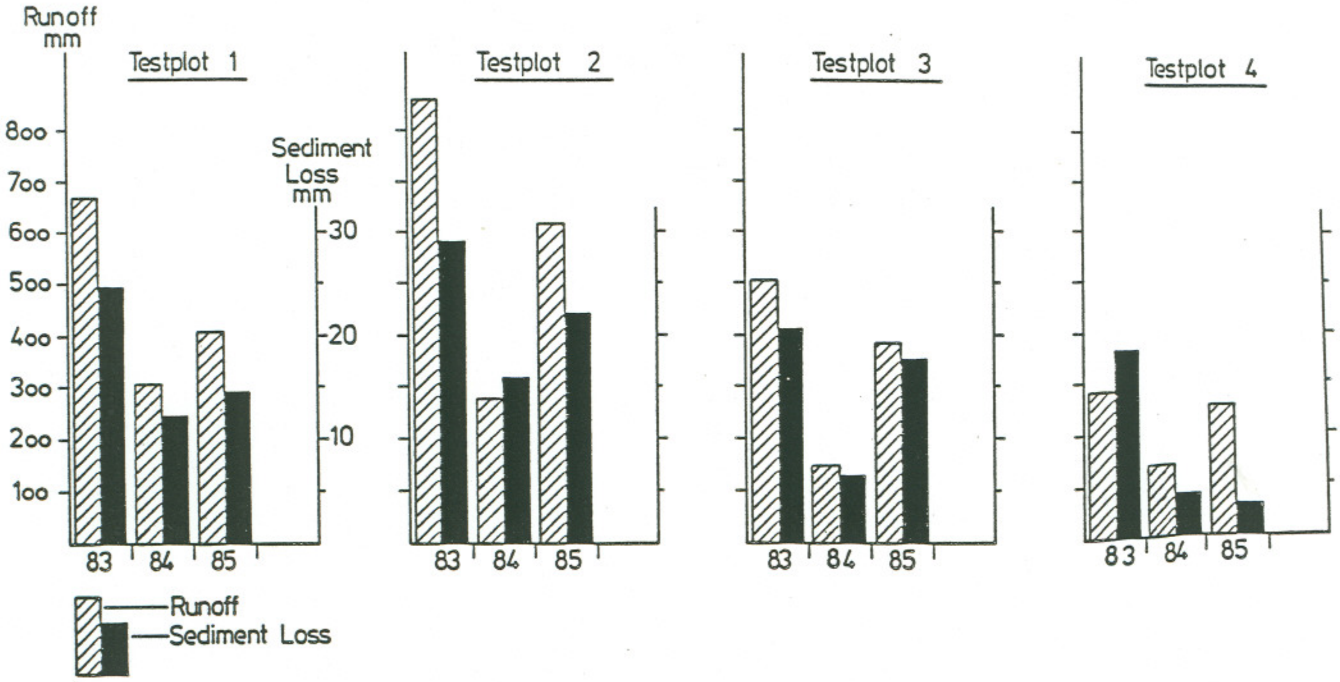
Figure 4 presents monthly summaries of rainfall, evaporation and min-max temperatures. Clearly emerging is the bimodal rainfall regime with a small rainy season in March - May, and a big rainy season in July - September. The drought year 1984 also affected the catchment, but did not lead to crop failure. However, the small rainy season 1984 produced very low yields due to insect problems.

Figure 5 presents monthly catchment runoff and sediment loss values from 1982 to 1984. The catchment is 4.81 km2, out of which about 40% is cultivated land, some 10% forest or afforestation land and the remaining 50% grassland. Runoff from the catchment is well related to monthly rainfall (see Figure 4) with a marked lowering during the drought year 1984. Sediment loss, on the other hand, is more related to crop stage. Months of low vegetation cover on the cultivated fields result in very high sediment yields. As examples, see August 1982, May 1983, May 1984, and July 1984. On the contrary, sufficient rainfall in July 1983 resulted in such good vegetation growth that high rainfall in August 1983 brought about only relatively low sediment losses.

Annual soil loss and runoff rates are summarized in Figure 6, indicating the horrifying rates measured on the four testplots in the catchment. Testplot 1 with a highly degraded eutric Regosol on a 23% slope was only cultivated once, in 1985, but always had high annual losses between 10 and 20 mm soil depth. Testplot 2, on a chromic Cambisol with a 39% slope, cultivated every year in the main rainy season, had highest losses of average 20 mm soil depth annually. With this rate, 20 cm will be lost in 10 years only, resulting in a very rapid decline of soil productivity. Testplot 3, situated on a degraded eutric Regosol with a 48% slope, cultivated in 1984 and 1985, had losses around 15 mm per year while testplot 4, situated on an ochric Andosol of 48% slope, lost almost 20 mm in 1983 when barley was grown in the main rainy season, but markedly less in 1984 and 1985. In 1985, peas were grown in the small rainy season, thus resulting in low soil loss despite normal rains for testplot 4.

Soil formation rates in this catchment are estimated to be around 2 t/ha/year or 0.2 mm soil depth per year. Cultivated slopes, therefore, degrade at a rate 100 times faster than regeneration (see Hurni, 1983).

Of importance for soil erosion assessment is the erodibility of soils, mapped by R. Bono and W. Seiler and presented in Figure 7. The most important result is the fact that erodibility of the soil increases with degree of soil destruction (see soil map), class III being typical for Andosols and class IV for Regosols. An increase of soil erosion from bare plots of some 20% can be expected compared to an undisturbed soil.




| | Soil Loss [qt] | Yield [kg] | SL | Y | SL | Y | Total SL | Total Yield |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | 1983 | | 1984 | | 1985 | | | |
| | J F M A M J J A S O N D | | J F M A M J J A S O N D | | J F M A M J J A S O N D | | | |
| TP 1 | | | | F P | F | P Lentile F | | |
| | 7.4 | - | 3.7 | | 4.4 | Lentile 3.02 | 15.5 Qt | Lentile 3.02 Kg |
| TP 2 | F | P Lentile F | F | Wheat | F P | Lentile F | | |
| | 8.7 | Lentile 1.75 | 4.7 | | 6.7 | Lentile 0.87 | 20.1Qt | Lentile 2.59Kg |
| TP 3 | F | | P | Linseed | F P | Lentile F | | |
| | 6.2 | - | 1.9 | | 5.3 | Lentile 1.42 | 13.4 Qt | Lentile 1.42Kg |
| TP 4 | F P | Barley F | | Barley | Peas | P F | | |
| | 5.5 | Barley 7.85 | 1.2 | | 0.9 | Peas 0.53 | 7.6Qt | Barley 7.85 Peas 0.5[illegible] Kg |

F: Fallow
P: Ploughed

*Figure 6: Testplot runoff, soil loss and production data for Andit Tid Station, Shewa Research Unit, SCRP.*

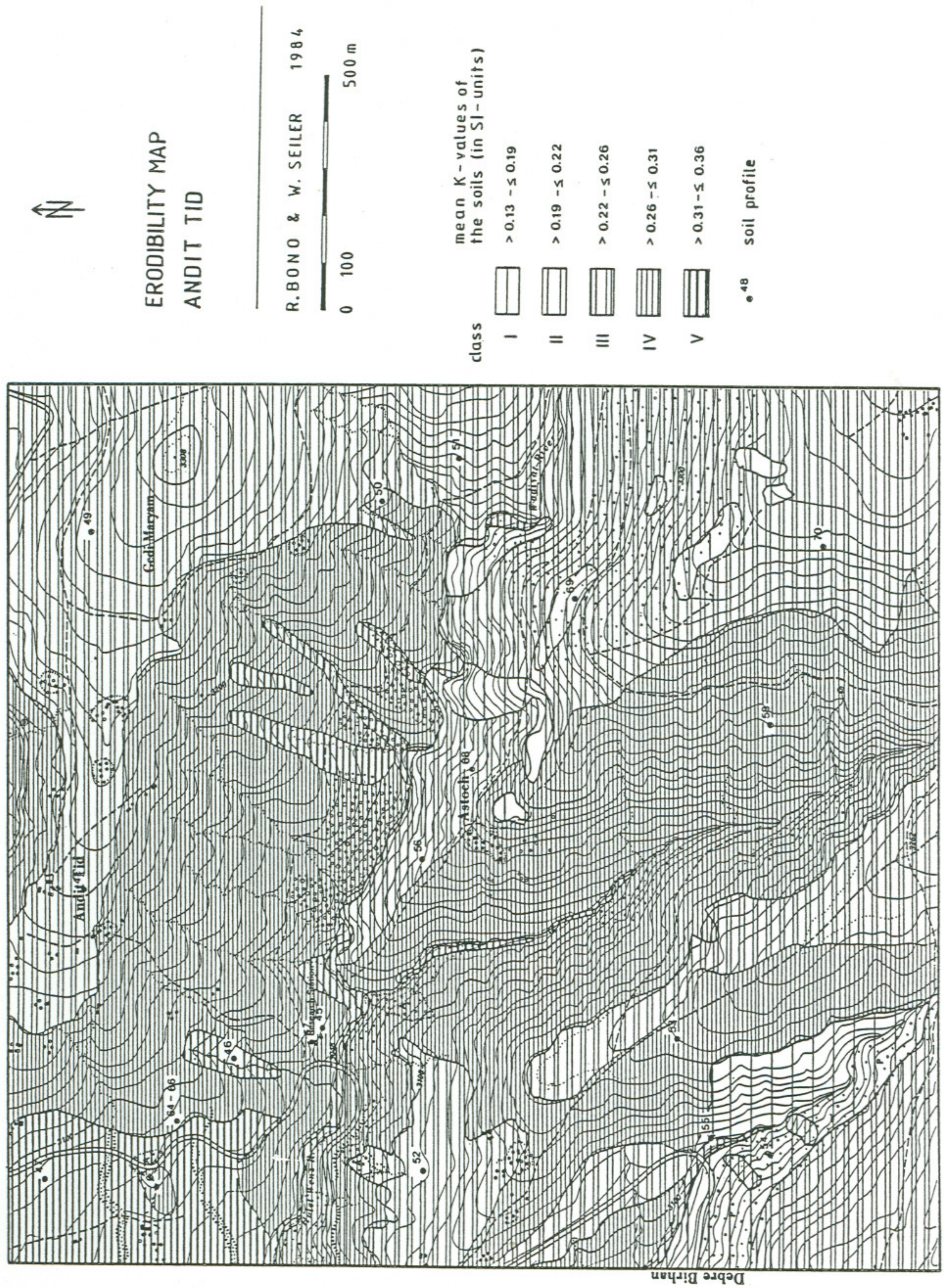



*Figure 7: Soil erodibility around Andit Tid Station, Shewa Research Unit, SCRP (Bono and Seiler, 1984).*

*Sources of Information:*


Erni, T., 1986: Land cover map of Debre Birhan area, scale 1:100'000. SCRP, Addis Abeba.

Hurni, H., 1986: Shewa Research Unit, Andit Tid Station: An excursion guide for visitors. SCRP, Addis Abeba.

Bono, R. and Seiler, W., 1984: The soils of the Andit Tid Research Unit (Ethiopia). Research Report 3, SCRP, Addis Abeba, 80 pp.

Bono, R. and Seiler, W., 1984: Erodibility in the Suke-Harerge and Andit Tid Research Units (Ethiopia). Research Report 5, SCRP, 21 pp.

## 3.4. Stops on Friday, 24 October 1986

### *(1) Denneba Vertisol Management Project*

The International Livestock Centre for Africa (ILCA) in conjunction with the Government of Ethiopia and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is carrying out a research, training and outreach operation on improved management of deep black clay soils (Vertisols) in the Ethiopian highlands (see photo p.18).

Research activities focus on three key elements of improved Vertisol management:

1. Establishment of a surface drainage structure:
A Low-cost modification of the traditional animal drawn plough (an ard, in Amharic called "maresha") is used to establish raised beds with drainage furrows of about 20 cm depth at 1.2 m distance. This surface drainage removes water logging which is the most important plant growth constraint on Vertisols in high rainfall areas. A doubling of crop yields can be expected by this drainage intervention.

2. Devise of more productive cropping systems:
As soon as the waterlogging constraint is removed, other, more productive crops than the traditional ones can be grown and the full length of the growing period can be used for crop growth. Traditional Vertisol cropping tends to utilise residual moisture (late planting) rather than the main rainy season for cropping. The Vertisols are thus considerably underutilised.

3. Soil fertility and animal feed management:
Higher crop yields from drained Vertisols imply higher nutrient offtake from the soil. Strategic inputs are required in order to sustain crop yields at higher levels. The inputs mainly concern P and N. Nitrogen can be produced, both for plant and animal nutrition, on the farm using lenguminous crops.

Outreach activities have been implemented in four different highland Vertisol environments. They mainly deal with the on-farm verification of the animal-drawn implement for the construction of Broad-Beds-and-Furrows (BBF).

#### *Denneba Outreach Sub-Project*

The traditional farming system on the Innewari-plateau shows a good application of the key-techniques of improved Vertisol management, i.e. Broad-Beds-and-Furrows. Therefore, and in contrast to the other outreach sub-projects of the Vertisol project, the introduction of BBF is not an issue there.

The BBF are traditionally made by hand without tools (mainly woman and child labour). There is an opportunity, therefore, to save labour by the animal-drawn Broad-Bed-Maker (BBM). The traditional hand-making of BBF requires about 60 hours human labour input. The input drops to about 15 hours when using the BBM.

Ten hectares of horse bean, wheat and fenugreek have been planted using the BBM on a producers' cooperative, and a similar area with traditional management was closely monitored for all inputs for comparison purpose.

A detailed base-line survey on the entire plateau has been carried out to prepare an extension of the outreach activities and to provide reference information for impact assessment.

*Source of Information:*

Dr Samuel Jutzi, ILCA

## *(2) Mennagesha State Forest View*

### *A Short Historical Commentary*

The Mennagesha forest is located about 53 km SW of Addis Abeba, 38 33'E and 8 58'N. It is part of the volcanic dome of Mount Wechecha, with altitudes varying from 2440 m asl in the lower part to 3300 m asl at the summit.

The Mennagesha forest is one of the few remaining forests in central Ethiopia. It is said to have been started by planting seeds from trees found in Wef Washa forest near Debre Sina by the direction of King Zera Yakob (1434-1468) (Gilbert, 1970). According to the same author the forest has been protected by imperial edict since the 1600's. Later on, Emperor Menelik II (1888-1912), in order to protect the forest, employed guards and proclaimed that no one was allowed to cut trees without his approval. Special mention was made of the three important trees in the forest, Tid (Juniperus procera), Zigba (Podocarpus gracilior) and Weyra (Olea europaea var africana).

In 1900 a sawmill was established within the forest by a German industrialist named Otto. This sawmill was probably one of the major destructive forces of the forest.

In 1956, an afforestation programme was initiated in the lower part of the forest in the Suba area by the Forestry and Wildlife Division under the Ministry of Agriculture. Various species of Pinus and Eucalyptus were introduced for trials. During that time the forest was used as a training centre for field oriented courses of the Ambo Forestry School.

The original forest cover was estimated to be about 7360 hectares. At present, the forest covers only about 2720 hectares. Thus in the past many years about 4600 hectares, i.e. 62.5% of the original forest was destroyed. In 1984 an area of 9557 hectares was delimited to be part of the Mennagesha State Forest and steps are being taken to reafforest the already deforested area with both indigenous and introduced trees.

Much of the information in this paper is extracted from a study report (Tadesse, 1986).

### *Sources of Information:*

E.F. Gilbert, 1970: Mt. Wechecha: A botanical commentary. Walia No. 2:3-12.

Tadesse Worku, 1986: A study report on the protection and development of natural forests. Ministry of Agriculture, Addis Abeba (mimeograph).

## 4. M A P S

## Topography and Itinerary

Source: Ethiopia 1:2 million. Ethiopian Mapping Agency.

Scale: 1:2 million — 0 ______ 100 km

Legend: Contours are at 200 m vertical intervals, with intermittent 100 m lines

Elevations are in metres

↖③ Stops on Tuesday, 21 October 1986 (See pages 21, 25, 26, 28)

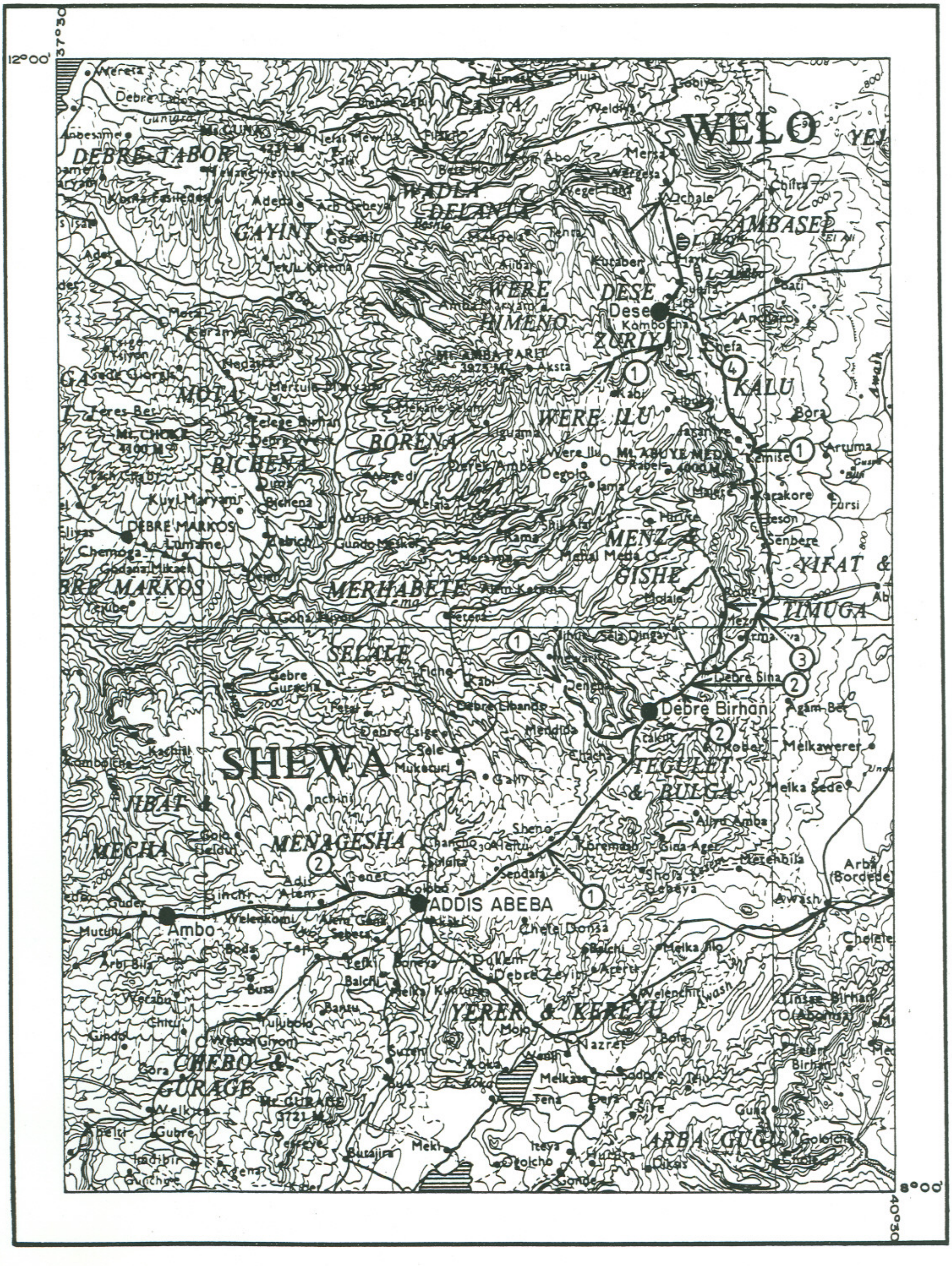
①↗ Stops on Wednesday, 22 October 1986 (See page 30)

←② Stops on Thursday, 23 October 1986 (See pages 42, 43)

②↘ Stops on Friday, 24 October 1986 (See pages 56, 58)

● Overnight locations

Note: Directions of arrows are different for the different excursion days, numbers refer to Chapter 3. Background Information (p.21).



12°00'
37°30'
8°00'
40°30'
WELO
LASTA
DEBRE TABOR
GAYINT
WADLA
DELANTA
AMBASEL
WERE
HIMENO
DESE
Dese
ZURIY
KALU
MOTA
WERE ILU
BORENA
BICHENA
DEBRE MARKOS
MENZ
GISHE
YIFAT &
TIMUGA
MERHABETE
SELALE
Debre Birhan
Debre Sina
SHEWA
TEGULET
& BULGA
JIBAT &
MECHA
MENAGESHA
ADDIS ABEBA
Ambo
YERER & KEREYU
CHEBO &
GURAGE
ARBA GUGU
Nazret
Awash
Fiche
Kombolcha
Weldiya
Kemise
Debre Zeyit
Mojo
Meki
Melka Sede

## Mean Annual Rainfall

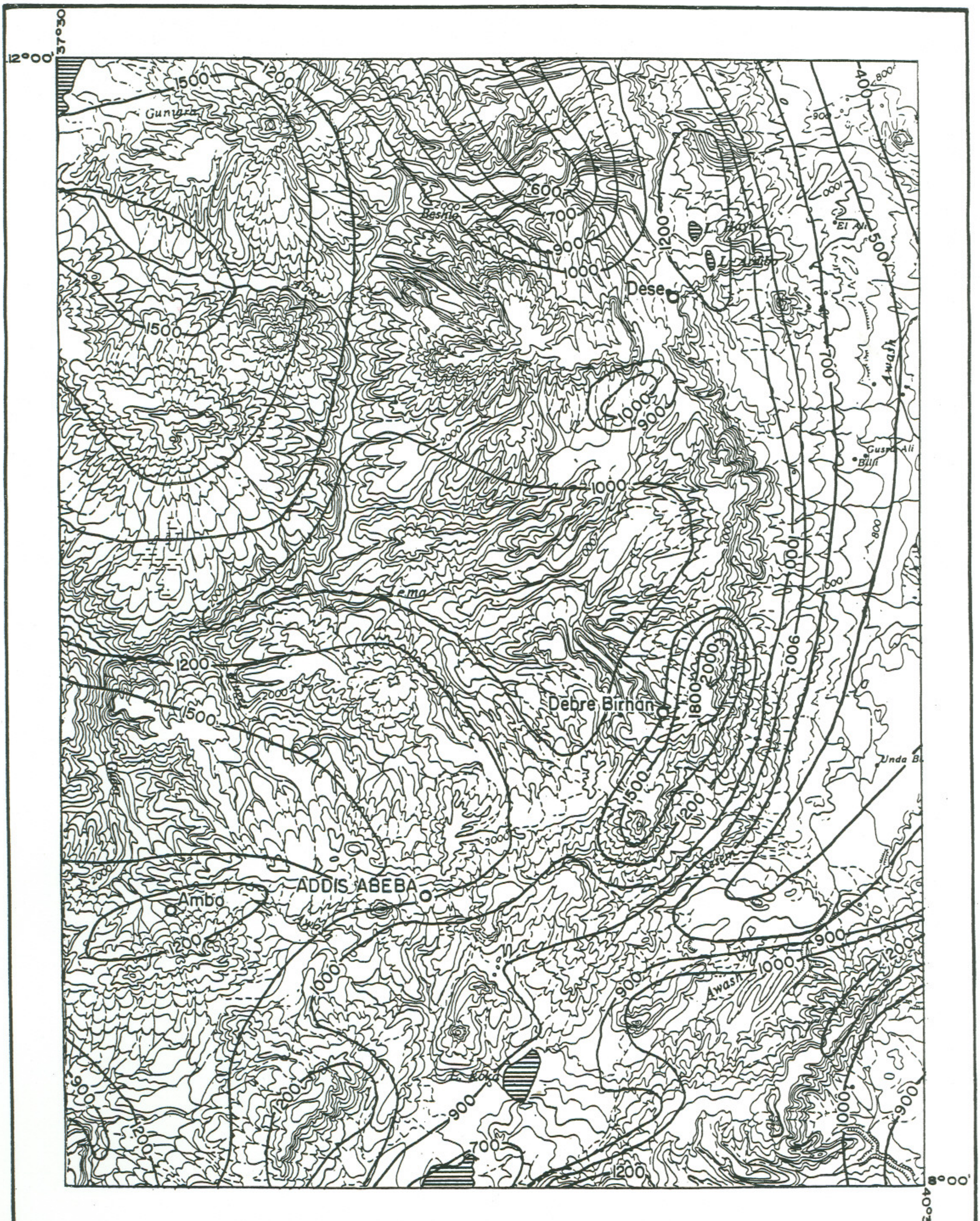
Source: Victor A.O. Odenyo and Wolfgang Göbel, 1982: Mean annual rainfall Ethiopia, 1:2 million scale.Land Use Planning and Regulatory Department, Ministry of Agriculture, Ethiopia

Scale: 1:2 million        0 ——— 100 km

Legend: Annual rainfall isohyeths are given in millimetres

Meteorological data from:

- National Meteorological Services Agency
- Ethiopian Water Resources Authority
- Water Resources Development Authority
- Ministry of Agriculture
- Italian Cultural Institute, Addis Abeba


12°00'
37°30'
Beshlo
L. Hayk
Dese
El Ali
Awash
Jema
Debre Birhan
ADDIS ABEBA
Ambo
Awash
L. Koka
8°00'
40°30'

## Length of Growing Periods

Source: Land Use Planning and Regulatory Department, Ministry of Agriculture, Ethiopia, 1982

Scale: 1:2 million  0 —— 100 km

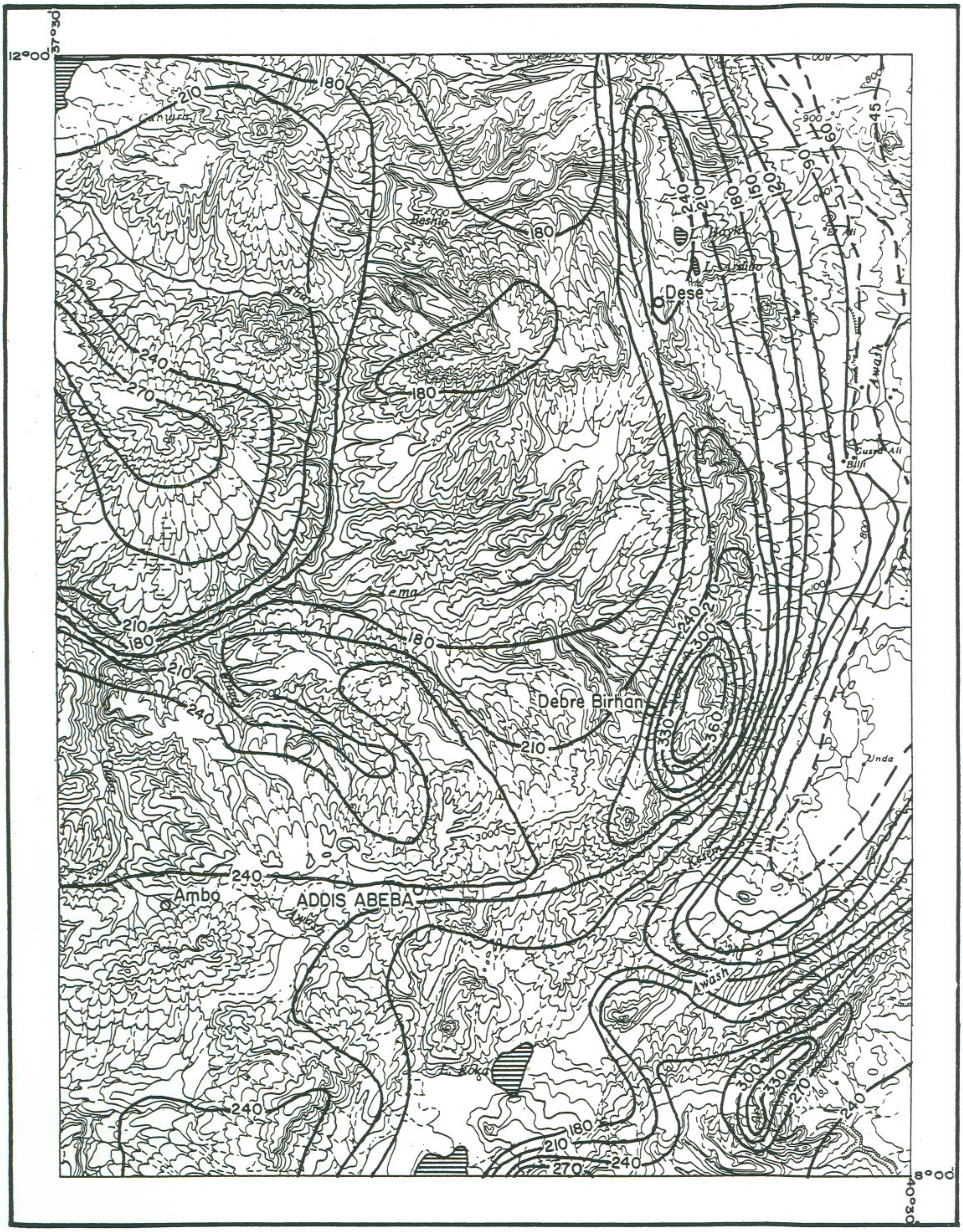
Legend: Length of growing periods are given in days per year

Explanation:

The growing period, counted in days, is the period during a year when rainfall exceeds one half the potential evapotranspiration (PET). If rainfall exceeds one full PET, soil moisture storage is built up. In this case, the amount by which rainfall exceeds PET, up to a maximum of 100 mm, is assumed to be soil moisture storage. The number of days required to evapotranspirate the soil moisture is then counted as part of the growing period. In addition, any time interval during the period when water is available but temperatures are too low for plant growth, as may happen at high altitudes, is excluded.

The growing period is <u>normal</u> (solid lines) when it has a time interval when rainfall exceeds one full PET. It is <u>intermediate</u> (dashed line) when the rainfall remains between one half and one full PET.

The calculation of the growing period is based on a simple water balance model comparing rainfall with PET (calculated according to Penman's 1948 formula).



12°00'
37°30'
8°00'
40°30'
Dese
L. Hayk
Debre Birhan
ADDIS ABEBA
Ambo
Awash
Bilti
Unda
L. Koka
Beshlo
180
210
240
270
300
330
360
150
120
90
60
45

## Climax Vegetation

Source: Sture Marklund, 1982: Climax vegetation Ethiopia, 1:2 million scale. Land Use Planning and Regulatory Department, Ministry of Agriculture, Ethiopia

Scale: 1:2 million — 0 ——— 100 km

Legend: <u>Climatic Climax Vegetation</u>

1 Afroalpine Region
2 Subafroalpine Region
Forest Region
3 Juniperus forest
4 Arundinaria forest
5 Podocarpus forest
6 Aningeria forest
7 Olea forest
8 Baphia forest
Woodland Savannah Region
9 Juniperus woodland
10 Acacia woodland
11 Mixed deciduous woodland
12 Steppe Region
13 Semidesert Region

<u>Edaphic Climax Vegetation</u>

Wetlands
14 Papyrus-Typha swamp
15 Echinochloa and Tamarix mannifera marsh
16 Riverine Forests
Grasslands
17 Hyparrhenia rufa grassland
18 Hyparrhenia filipendula grassland
19 Sorghum purpureo-cericeum grassland
20 Cenchrus ciliaris grassland
21 Chrysopogon aucheri-Dactyloctenium scindicum g'land
22 Aristida grassland
23 Halophytic Vegetation


12°00'
37°30'
Dese
L. Hayk
L. Ardibo
El Ali
Beshlo
Awash
Debre Birhan
ADDIS ABEBA
Ambo
8°00'
40°30'

## LAND USE AND LAND COVER

Source: Victor A. Odenyo and Mengistu Negash: Land use and land cover Ethiopia, 1:1 million scale. Land Use Planning and Regulatory Department, Ministry of Agriculture, Ethiopia (1984).

Scale: 1:2 million — 0 100 km

Legend:

| | |
|---|---|
| 1.0 | Urban or built-up land |
| 2.1 | Cultivated land (State farm) |
| 2.2 | Intensively cultivated |
| 2.3 | Moderately cultivated |
| 2.4 | Perennial crop cultivation |
| 3.0 | Afro-alpine and sub afro-alpine vegetation |
| 4.1 | Dense coniferous high forest |
| 4.2 | Dense mixed high forest |
| 4.3 | Disturbed high forest |
| 5.1 | Dense woodland |
| 5.2 | Open woodland |
| 5.3 | Eucalyptus woodland |
| 6.0 | Riparian woodland or bushland |
| 7.1 | Dense bushland |
| 7.2 | Open bushland |
| 7.3 | Lowland bamboo bushland |
| 8.1 | Dense shrubland |
| 8.2 | Open shrubland |
| 9.1 | Open grassland |
| 9.2 | Bushed shrubbed grassland |
| 9.3 | Wooded grassland |
| 10.1a | Perennial swamp |
| 10.1b | Seasonal swamp |
| 10.2a | Perennial marsh |
| 10.2b | Seasonal marsh |
| 11.1 | Exposed rock surface |
| 11.2 | Salt flats |
| 11.3 | Exposed sand soil surface |
| 11.4 | Exposed sand soil surface with scattered scrub and grass vegetation |
| 11.5 | Exposed rock surface with scattered scrub and grass vegetation |
| 12 | Water body |

12°00'
37°30'
Dese
Debre Birhan
Ambo
ADDIS ABEBA
8°00'
40°30'