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Vegetation of stabilizing and eroding slopes in eastern Nepal

Die Vegetation stabilisierender und erodierender Hänge in Ostnepal

by

Ruth SCHAFFNER

1987

CONTENTS

Tables in the pocket of the cover: Table 3.1, Tables 4.1 to 4.13, 4.15

PREFACE

One of the important goals of the Lamosangu-Jiri Road Project (LJRP) in East Nepal was erosion control. My husband was Co-Manager of this joint Nepali-Swiss project from 1981 till 1986. In 1982, during the intensive planting campaign of summer, I got quite involved in the discussions and measures that were taken. This gave the impulse for the present study.
Since then I had to overcome numerous hurdles, which I could not have done without the support of a large number of people. First of all I should like to thank Professor Dr. F. Klötzli for guiding me through this research with his wide knowledge on ecological contexts; then Professor Dr. H. Wanner (Institute of Plant Physiology, University of Zürich) who smoothed out the first difficulties; with Professor Dr. H. Sticher I had fruitful discussions on soil; Professor Dr. B. Messerli, Dr. H. Hurni and Dr. H. Kienholz (Geographical Institute, University of Berne) gave invaluable advice on my erosion research; I am grateful to all these experts for their help. My thanks also go to the Swiss Technical Cooperation for their financial assistance and their permission to use the facilities of LJRP and the Integrated Hill Development Project (IHDP).
Among the many other persons and institutions involved in my study I would like to mention the following ones:

- Mr. A. Frischknecht, Director Swiss Association for Technical Assistance in Nepal, and Mr. H. Moos, Co-Manager IHDP, who gave me any support necessary.
- Dr. Kk. Panday, International Centre for Integrated Mountain Development ICIMOD, Kathmandu, introduced me to different institutions in Kathmandu; he was alwasy ready for any assistance and extensive discussions about my study.
- The whole staff of LJRP was very cooperative: especially Mr. N. Joshi and Mr. R. Schrämli helped with technical advice and practically; the farmers Bim Bahadur Bhandari and Khil Bahadur Bhandari were reliable assistants in my field work.
- I was allowed to use the Herbarium of the Department of Medicinal Plants (Director Dr. S.B. Malla) and I got direct help from Mrs. Dr. V.L. Gurung, Dr. K.R. Rajbandari, Dr. P.R. Shakya with the identification of questionable species.
- The Meteorological Service of Nepal provided a recording raingauge for the erosion research.

- I could use the Laboratory of the National Potato Development Project in Kumaltar, Kathmandu, to treat the soil samples.
- Mrs. M. Bigler and Mrs. C. Hayden made valuable suggestions on style and use of the English language.
- Mr. D. Vuichard, Institute of Mineralogy and Petrography, University of Berne, gave an extensive introduction into the geology of my project region.
- The staff of the Geobotanical Institute ETH, especially Mr. H.R. Binz, was very helpful during the mathematical evaluations; Mrs. R. Flubacher and Mrs. A. Honegger word-processed the final draft.
- The Swiss Federal Research Station for Agronomy, Reckenholz, Zürich, promptly analysed the soil samples.
- Mrs. Dr. P. Geissler of the Herbarium of Geneva identified the mosses.
- The Güller family gave me great support during the hard time of the evaluations in January 1986 in Switzerland.
- Mrs. L. Guttentag, Mrs. I. and Dr. K. Hausherr helped decide on the feasibility of the study.
- My parents were always willing to shop for things not available in Nepal.

My sincere thanks go to all these persons and institutes as well as to numerous people not mentioned here.
But most of all I want to thank my husband, who has given me tremendous support in word and deed from the beginning, and my children, who had to manage without me during the long weeks of the field survey in Nepal and the time of the evaluations in Switzerland.

1. INTRODUCTION

1.1. GENERAL

"Soil degradation in its broadest sense is one of the major problems facing the world at this moment... The soil is, and will for the foreseeable future be, the basis for food production... Obviously there is going to be much greater pressure on the land." This excerpt from a FAO-publication (1983) shows the seriousness of the problem of soil degradation, of which erosion is a major part.

Erosion includes all processes that result in the physical wearing down of the surface of the earth. Erosion processes are complex, consisting of "natural" (geological) erosion and "accelerated" (man induced) erosion (CARSON 1985).

The problem of erosion is especially acute in Nepal for the following reasons:

- Natural erosion rates are very high because of the constant tectonic uplifting of the major mountain ranges and consequent downcutting of the river systems. The net result of these unrelenting forces are unstable slopes that cannot maintain their river-canyon form. Natural erosion is characterized by different forms, particularly rock failures, landslides, slumps, riverbank cutting and gullying.
- Pressure on limited land resources by the steadily growing population results in increased land degradation due to forest clearing, overgrazing, poor maintaining of marginal arable land, and fire. The resulting accelerated erosion is mainly characterized by the loss of topsoil by sheet and rill erosion and gully building (SHARMA 1974, LABAN 1978, NELSON 1980, IVES and MESSERLI 1981, KIENHOLZ 1981, KIENHOLZ et al. 1983).
- Increasing activity in construction work, such as dam and road building, is also an important cause of land degradation. This will grow in importance with the advancing development of the country (NELSON 1980).

1.2. FACTORS CONTROLLING EROSION

Loss of topsoil by surface erosion is the direct result of heavy rains pounding unprotected soils. This erosion consists of two stages: first the separation of the soil particles, and secondly their transport or removal by runoff. The cumulative effect is the impoverishment of the soil base. It is necessary to develop a method whereby surface erosion can be quantified. The major physical factors controlling the rate of erosion by water are (FAO 1983):

- Rainfall: The power of rainfall to produce erosion (i.e. its erosivity) is related to its amount, intensity and distribution, and is therefore a factor of climate.
- Vegetation and soil cover: Where there is a growth of vegetation, the parts above ground intercept and absorb the force of the rainfall, and the amount of energy thus intercepted and neutralised is directly proportional to the amount of land surface covered by the vegetation. In addition, fallen leaves, etc. and plant roots protect the soil and improve its structure, infiltration rate, and moisture storage capacity, and retard runoff. Vegetative cover also influences the effect of sun and wind on the soil surface and this in turn affects its erodibility.
- Soil: Soils vary in their resistance to erosion (their erodibility). Part of this is inherent in the soil, and is related to texture (mainly clay content) and amount of organic matter, and part depends on soil condition and depth. A soil with a well developed and stable crumb structure will resist particle separation longer, and will also absorb rainfall faster, thus reducing the amount of destructive runoff. Runoff will also tend to be reduced in proportion to the depth of a soil. It is also evident that the more fertile and less degraded the soil, the greater its ability to produce and support an effective vegetative cover.
- Topography: The degree of land slope has a very strong influence on the amount of erosion. Soil losses from steep slopes are much greater than from gentle slopes. Length of field and slope is also important. Surface roughness will retard runoff and decrease its quantity.
- Aspect: In some climates, and particularly when land slopes are greater than 3%, there is a relationship between the amount of erosion and the aspect of a field or the geographical direction it faces.

Scientists have developed a number of regional assessments characterizing soil erosion in Nepal (see Ref. in CARSON 1985, LAUTERBURG 1985). Such exercises are difficult to carry out because of the extreme variability found throughout the country. Rainfall erosivity, wind velocity, aspect, slope, bedrock type and characteristics, land use, forest type and condition must all be considered in the prediction of surface erosion.

Surface and topsoil erosion caused by rainfall can be estimated by the use of the Universal Soil Loss Equation (U.S.L.E.) (WISCHMEIER and SMITH 1978).

Briefly the U.S.L.E. is A = RKLSCP,

where A = the amount of soil loss in tons per ha

R = Rainfall erosivity

K = Soil erodibility

LS = Slope length and steepness

C = Cropping management

P = Erosion control measures

The Universal Soil Loss Equation was developed for gently sloping agricultural land in America and direct applicability to the mountainous regions of Nepal cannot be assured (FLEMING 1978, IWM 1980).

The aim of the investigations in hand is to observe the natural successional regeneration of vegetation in landslides and slopes. The connection between plant cover and amount of runoff and soil loss on steep slopes is examined. In conclusion the possibilities of decreasing erosion and stabilizing slopes by plant cover are discussed.

2. THE INVESTIGATION AREA

2.1. PHYSIOGRAPHY

The present study covers an area in eastern Sindhupalchok and western Dolakha District between the Sunkosi and Tamakosi Rivers in the central midlands of Nepal (Figs. 2.1, 2.2). The relief is hilly and steep and there are hardly any flat plains even along the rivers.

2.2. POPULATION

The region is - as the middle hills of Nepal generally are - characterized by dense population, and thus progressive deforestation and erosion (KHADKA 1981). Besides a few variably compact villages, the houses are scattered over the flanks and ridges of the area. The population density is recorded with 84 per km^2, with a per capita land holding of 0.04 ha (mean of Sindhupalchok and Dolakha District, Nepal District Profiles 1981).

A variety of people lives here. The dominating group are the Nepali-speaking Brahmin and Chhetri (over 50%) with their Hindu religion and caste system. They are followed by the Tamangs (over 20%), a Buddhist Tibeto-Burman-speaking community. Of the remaining groups the Newari (about 5%) should be mentioned (BISTA 1980, DOBREMEZ et al. 1974).

2.3. ECONOMY

The economy depends almost exclusively on agronomy, which is, because of the variation in climate, diverse. An elaborate terrace-system with mainly rice, wheat, maize and mustard in the lower parts and potatoes,

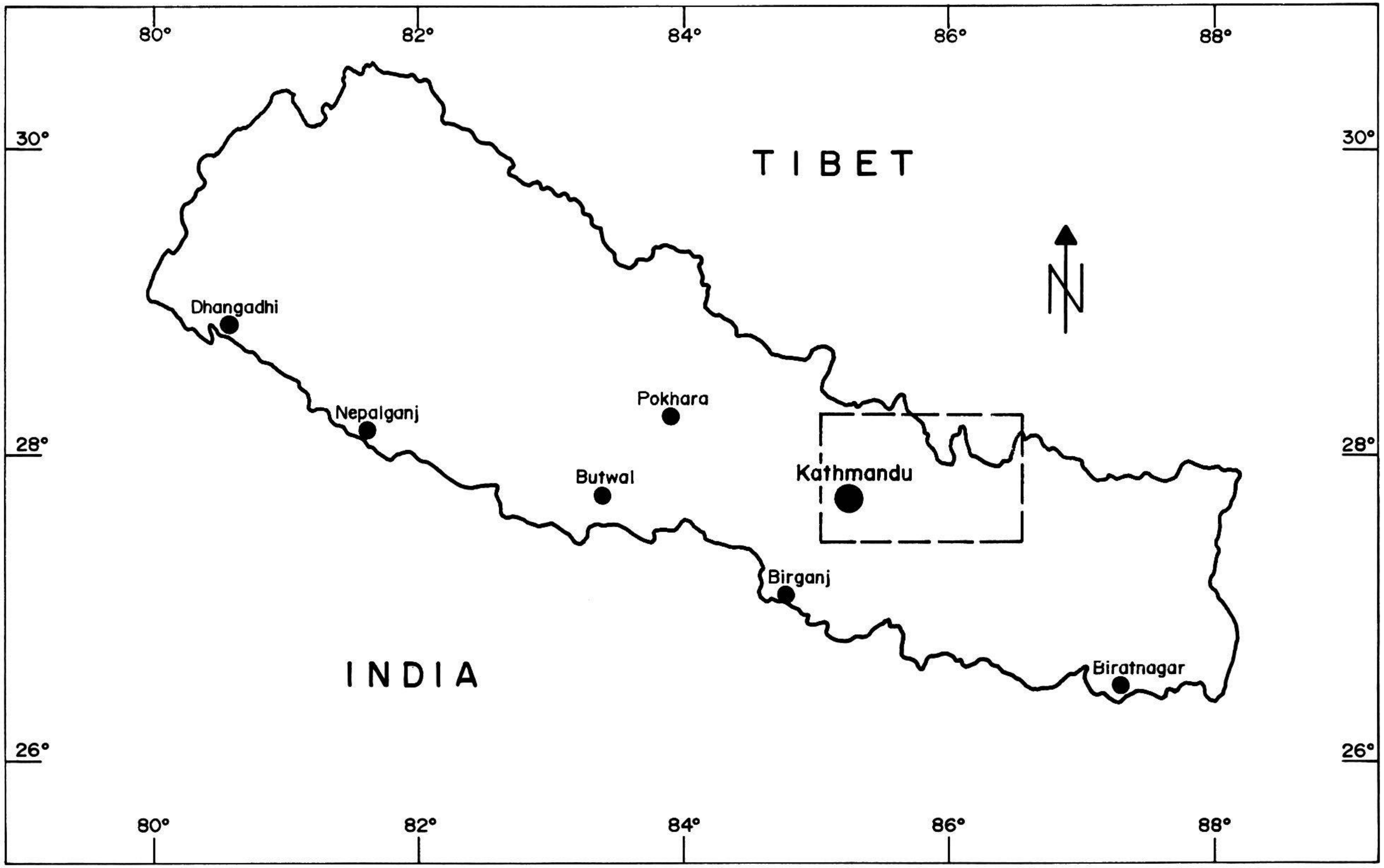

80°
82°
84°
86°
88°
30°
28°
26°
TIBET
N
Dhangadhi
Nepalganj
Pokhara
Butwal
Kathmandu
Birganj
Biratnagar
INDIA

Fig. 2.1. Nepal

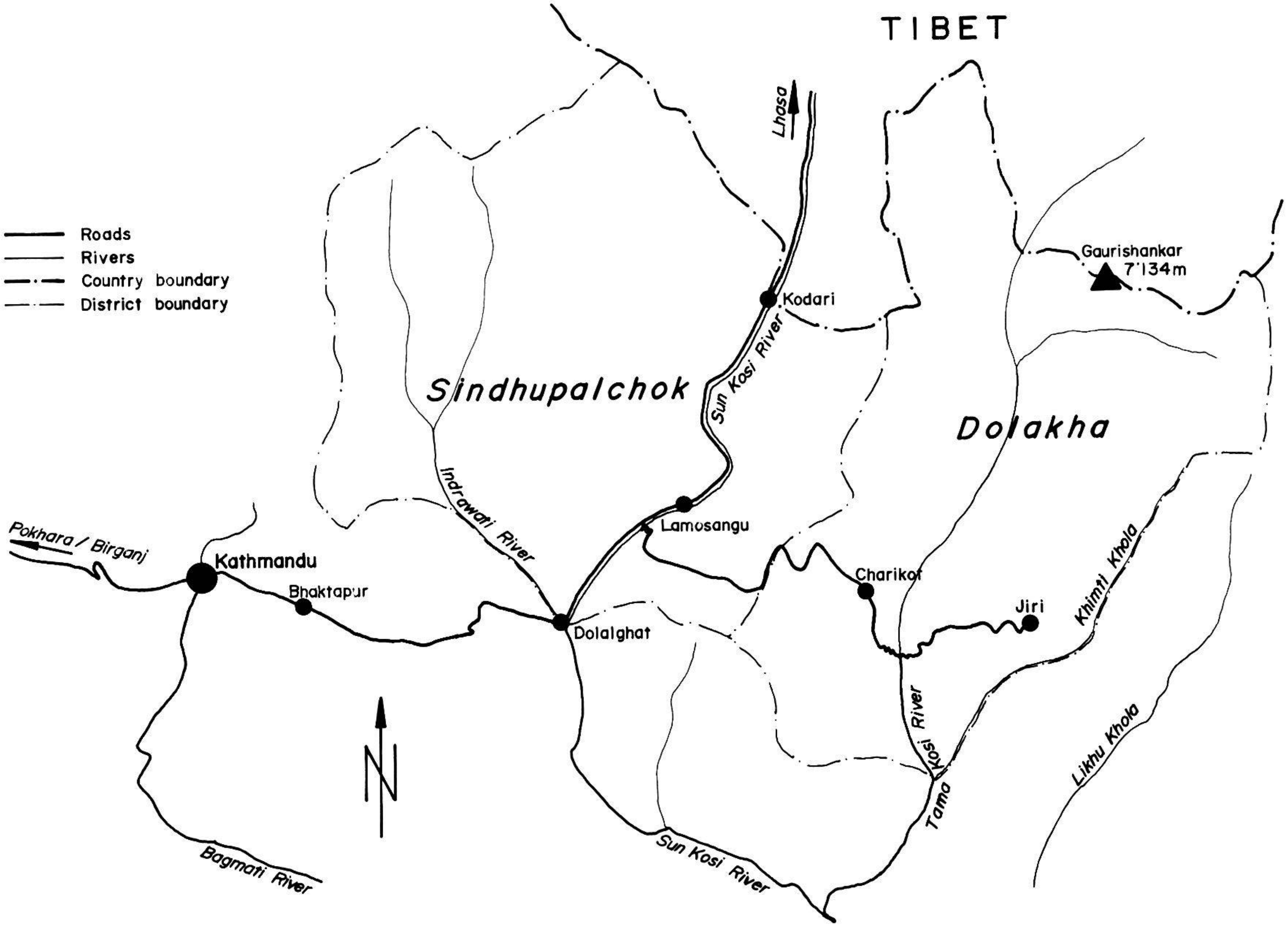


Fig. 2.2. Situation of study area
Abb. 2.2. Lage des Untersuchungsgebietes

maize, millet, barley and buckwheat in the higher areas can be seen, as can extensive pastures and shrubland or forests.
The whole region is easily accessible by the Arnico Highway, opened 1967 and leading from Kathmandu to Lhasa. It is one of the important trading routes to Tibet. The same highway is the gate to the whole Solu-Khumbu Region with its Sherpa community of Tibetan origin. This region, with Mount Everest as a magnet, is the destination of numerous mountaineering expeditions and trekkers.
A joint Nepali-Swiss Integrated Hill Development Project (IHDP) was started by the Swiss Technical Cooperation in 1974 with the aim of developing agronomy, education, forestry, health, small scale and cottage industry, and water supply and irrigation. The project entered its third phase, the handing-over, in 1985.
Also in 1974 and in connection with IHDP the Lamosangu-Jiri Road Project (LJRP) was started. From 1976-1985 a road of 110 km was built to connect the Arnico Highway with the Dolakha district (Fig. 2.2). In both projects much emphasis is laid on erosion control and protection of nature (NEVILLE 1985, SCHAFFNER 1985). The study in hand is part of this effort.

2.4. GEOLOGY AND TECTONICS

The Himalaya is a young tertiary mountain range still being uplifted. The most important structures of the present region are the WNW-ESE oriented folds and schuppen with the separating thrust faults. The rock can be diveded into three major types:
- crystalline rocks (various gneisses)
- metamorphic sediments (phyllites and cristalline schists)
- quaternary deposits (river deposits).

The most important types of rock are sediments of a low metamorphic grade. These are usually exceptionally schistous to thin-foliated, while the gneisses are thickly bedded. Often, very deep weathering attributable to heavy cleavage and rock characteristics can be observed. This results in a general instability, in much broken and displaced rock units (LJRP 1977). This instability is aggravated by earthquakes which

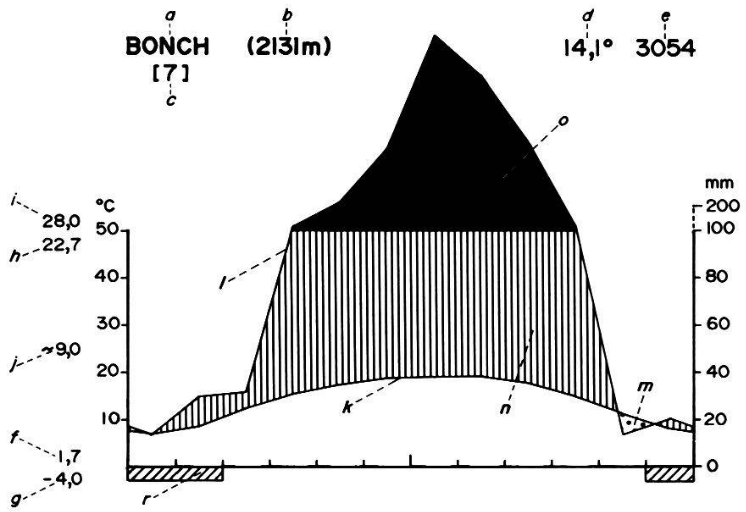
occasionally occur (HAGEN 1950-1958 and 1969, DONNER 1972, MARUO et al. 1973).
In most places, a variably thick covering of loose rock conceals the bed. This is composed of detritus and scree. The particle size distribution of this loose rock varies significantly. However, the coarse components (gravel, stones, blocks) are typically embedded in a silty, fine sandy matrix. There ist practically no clay (LJRP 1977).

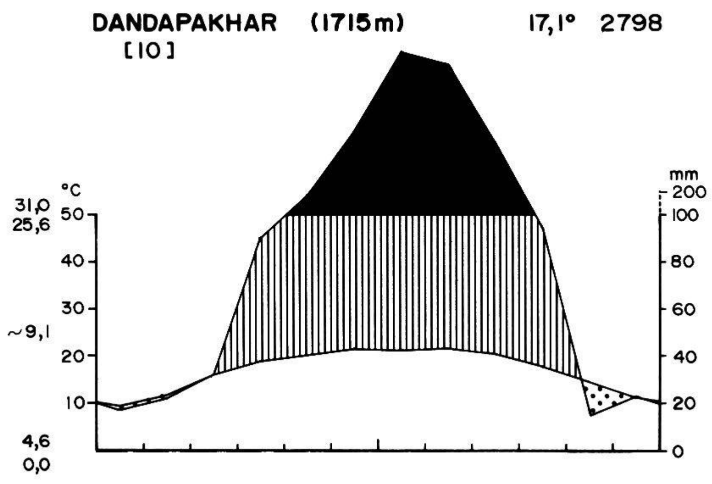
2.5. CLIMATE

Nepal has a monsoon climate, with a pronounced rainfall maximum during the months of June to September.
Owing to the irregular nature of the midland hills, the uneven topography and the extreme differences in altitude there exist different climatic belts (DONNER 1972, DOBREMEZ 1974b):

Fig. 2.3 (p. 15). Climate diagrams of the study area
(drawn by U. Schaffner, Emmenbrücke; IHDP-data)
Abb. 2.3 (S. 15). Klimadiagramme des Untersuchungsgebietes
(gezeichnet von U. Schaffner, Emmenbrücke; IHDP-data)

a - station
b - height above sea level
c - number of years of observation
d - mean annual temperature (in degrees centigrade)
e - mean annual precipitation (in millimeters)
f - mean daily temperature minimum of the coldest month
g - absolute minimum temperature (lowest recorded)
h - mean daily temperature maximum of warmest month
i - absolute maximum temperature (highest recorded)
j - mean daily temperature fluctuation
k - curve of mean monthly temperature (1 division = $10^{o}C$)
l - curve of mean monthly precipitation (1 division = 20 mm, i.e., $10^{o}C$ = 20 mm)
m - period of relative drought (dotted) for the climate region concerned
n - corresponding relatively humid season (vertical shading)
o - mean monthly precipitation >100 mm (scale reduced to 1/10) (black areas, perhumid season)
r - months with absolute minimum below $0^{o}C$ (diagonally shaded) i.e., with either late or early frosts


a
b
BONCH (2131m)
[7]
c
d
e
14,1° 3054
o
i
28,0
h
22,7
°C
50
40
30
20
10
j
~9,0
f
1,7
-4,0
g
l
k
n
m
r
mm
200
100
80
60
40
20
0


DANDAPAKHAR (1715m)
[10]
17,1° 2798
31,0
25,6
°C
50
40
30
20
10
~9,1
4,6
0,0
mm
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40
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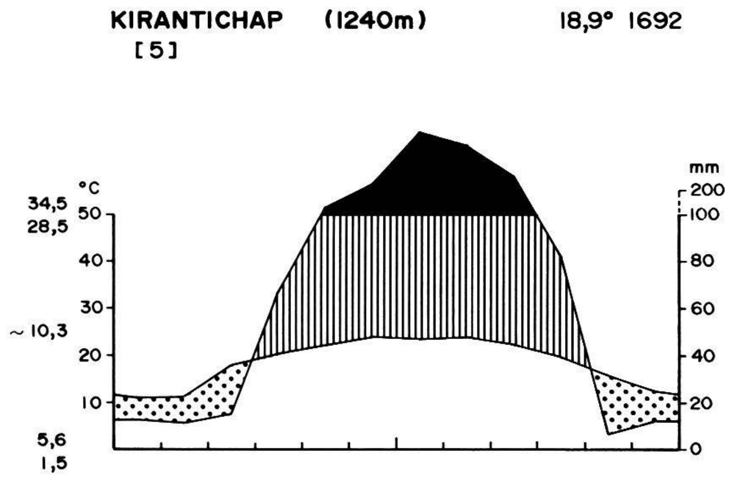
0


KIRANTICHAP (1240m)
[5]
18,9° 1692
34,5
28,5
°C
50
40
30
20
10
~10,3
5,6
1,5
mm
200
100
80
60
40
20
0

- hot monsoon belt (up to 1200 m)
- warm temperate monsoon belt (1200-2200 m)
- cool temperate monsoon belt (2200-3000 m)
- subarctic belt (3000-3800 m)
- arctic belt (from 3800 m).

IHDP has installed three meteorological stations. The rainfall figures recorded in the hills vary considerably according to the local topography. Bonch (2130 m a.s.l.; mean 1979-1984) has a yearly average of 3053 mm, Dandapakhar (1715 m a.s.l.; mean 1976-1984) 2830 mm and at Kirantichap (1240 m a.s.l.; mean 1981-1984) 1600 mm. 80-90% of the yearly rainfall occurs during the monsoon. There is a certain amount of rainfall during the winter months with possible snowfall above 2000 m from December to February (IHDP 1976-1985, Fig. 2.3).

The temperature varies mainly according to the altitude: Bonch shows a maximum mean of 18.5°C, Dandapakhar 21.8°C and Kirantichap 24.0°C. The minimum mean is 9.6°C at Bonch, 12.6°C at Dandapakhar and 13.8°C at Kirantichap. There can be frost in the coldest months from December to January above 1900 m (IHDP 1976-1985, Fig. 2.3).

2.6. VEGETATION AND SOIL

The vegetation is strongly connected with soil and climate, therefore we find a great variation in the Himalaya (SCHWEINFURTH 1957, STAINTON 1972). Acomparison of the vegetation zonation schemes of the Nepal Himalaya by different authors is given Fig. 2.4 (after OHSAWA 1974).

Owing to the high pressure of population the natural situation of the region has been considerably transformed: forests are rare. There is

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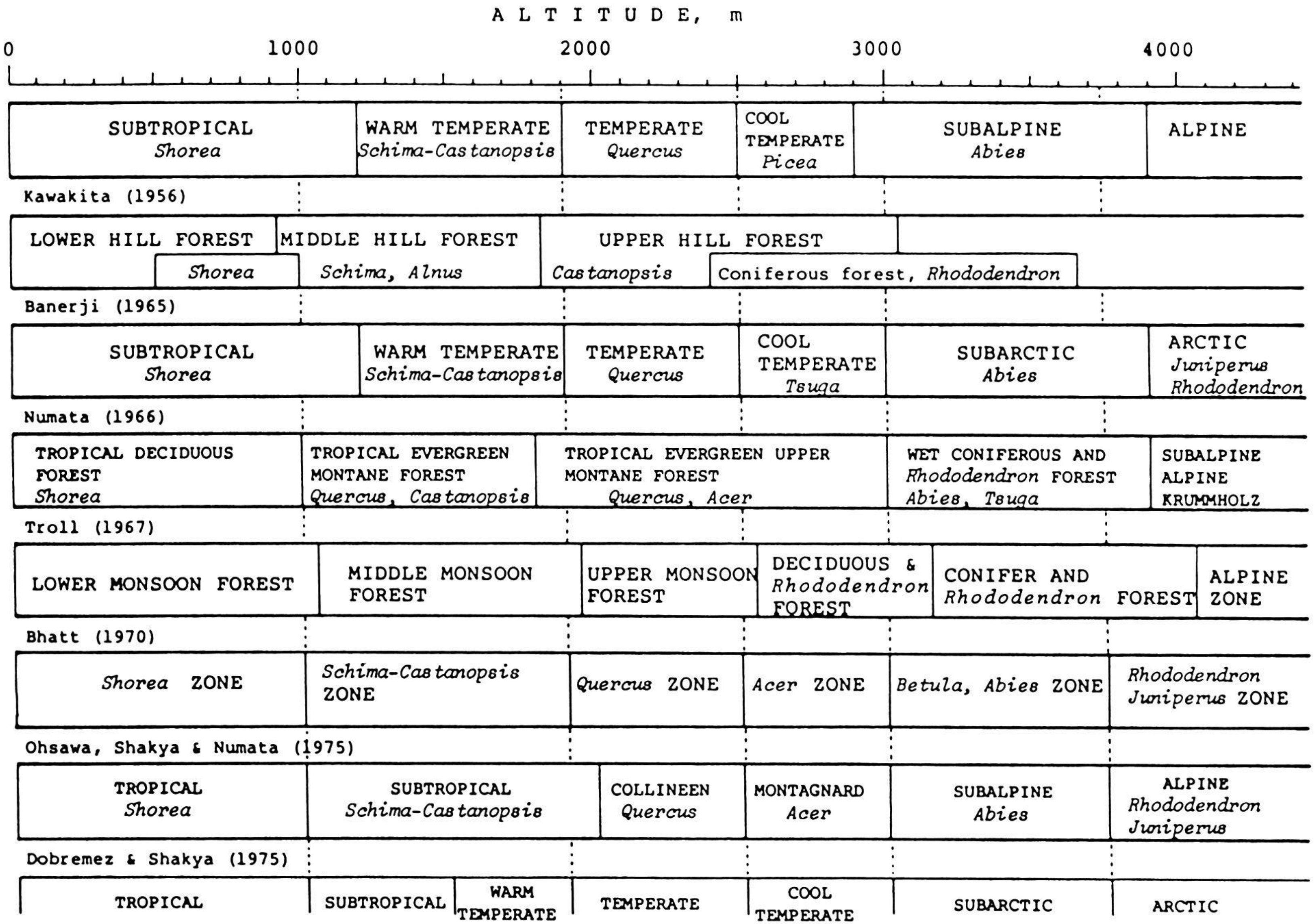
Fig. 2.4 (p. 17). Comparisons of vegetation zonation schemes in the Nepal Himalaya (after OHSAWA 1977)

Abb. 2.4 (S. 17). Vergleich verschiedener Darstellungen von Vegetationszonen im Nepal-Himalaya (nach OHSAWA 1977)


A L T I T U D E, m
0
1000
2000
3000
4000
SUBTROPICAL Shorea
WARM TEMPERATE Schima-Castanopsis
TEMPERATE Quercus
COOL TEMPERATE Picea
SUBALPINE Abies
ALPINE
Kawakita (1956)
LOWER HILL FOREST
Shorea
MIDDLE HILL FOREST
Schima, Alnus
UPPER HILL FOREST
Castanopsis
Coniferous forest, Rhododendron
Banerji (1965)
SUBTROPICAL Shorea
WARM TEMPERATE Schima-Castanopsis
TEMPERATE Quercus
COOL TEMPERATE Tsuga
SUBARCTIC Abies
ARCTIC Juniperus Rhododendron
Numata (1966)
TROPICAL DECIDUOUS FOREST Shorea
TROPICAL EVERGREEN MONTANE FOREST Quercus, Castanopsis
TROPICAL EVERGREEN UPPER MONTANE FOREST Quercus, Acer
WET CONIFEROUS AND Rhododendron FOREST Abies, Tsuga
SUBALPINE ALPINE KRUMMHOLZ
Troll (1967)
LOWER MONSOON FOREST
MIDDLE MONSOON FOREST
UPPER MONSOON FOREST
DECIDUOUS & Rhododendron FOREST
CONIFER AND Rhododendron FOREST
ALPINE ZONE
Bhatt (1970)
Shorea ZONE
Schima-Castanopsis ZONE
Quercus ZONE
Acer ZONE
Betula, Abies ZONE
Rhododendron Juniperus ZONE
Ohsawa, Shakya & Numata (1975)
TROPICAL Shorea
SUBTROPICAL Schima-Castanopsis
COLLINEEN Quercus
MONTAGNARD Acer
SUBALPINE Abies
ALPINE Rhododendron Juniperus
Dobremez & Shakya (1975)
TROPICAL
SUBTROPICAL
WARM TEMPERATE
TEMPERATE
COOL TEMPERATE
SUBARCTIC
ARCTIC

hardly any forest below 1900 m except in inaccessible areas or for cultural reasons or property conditions.
According to ESPINOSA (1974), the soils of the Lamosangu-Kharidhunga area have developed from metamorphic and sedimentary rocks, chiefly augengneiss, phyllite and metamorphosed sandstone. The major soils on bench terraces are well to poorly drained, strongly to moderately acid, slightly gravelly loams, silt loams and clay loams. Where forested, the soils range from excessively drained, stony sandy loams to well drained silty clay loams. Soil reaction is strongly to very strongly acid. The soils are mainly Cambisols, Acrisols and Regosols; a few Gleysols (classification by FAO-UNESCO 1974) occur along the rivers (ESPINOSA 1974, DOBREMEZ 1976).

3. METHODS

To record the plants, transects were laid through slopes and landslides along the Lamosangu-Jiri Road. The re-covering by plants was observed over a period of three years and the characteristics of each area were examined (Table 3.1, in the pocket of the cover of this volume). From this information an attempt was made to assess the influence of the different interfering factors: Meteorology, altitude, aspect, slope, soil, age of the slope/slide, influence of man and animals.
In addition, at different altitudes a series of surveys was carried out on various relatively stable but not undisturbed types of natural vegetation typical of the region. The floristic composition of the plots examined indicates the possible "climax" to be expected on the slopes in question.
At the same time, special attention was paid to runoff and soil loss in connection with amount and intensity of rainfall and plant cover on steep slopes. The experiments were carried out for one or two rainy seasons at two selected sites typical of the area. On both sites a comparison was made between an uncovered, landslide-like and a plant covered plot and the results are discussed more generally. The data gained also give the first information ever collected about rainfall intensity (erosivity), rainfall runoff and amount of soil loss in the project-region.

3.1. PHYTOSOCIOLOGICAL DATA

3.1.1. Transects

In order to record plant occurrence and succession, 45 fixed transects were laid through 35 landslides or slopes of different age (natural or man induced) representing various successional stages at an altitude of 1000 to 2600 m along 50 km of the Lamosangu-Jiri Road (Table 3.1 in the pocket of the cover of this volume, Fig. 3.1). The plots were examined over three years, that is in early monsoon (in June/July 1984 and 1985),

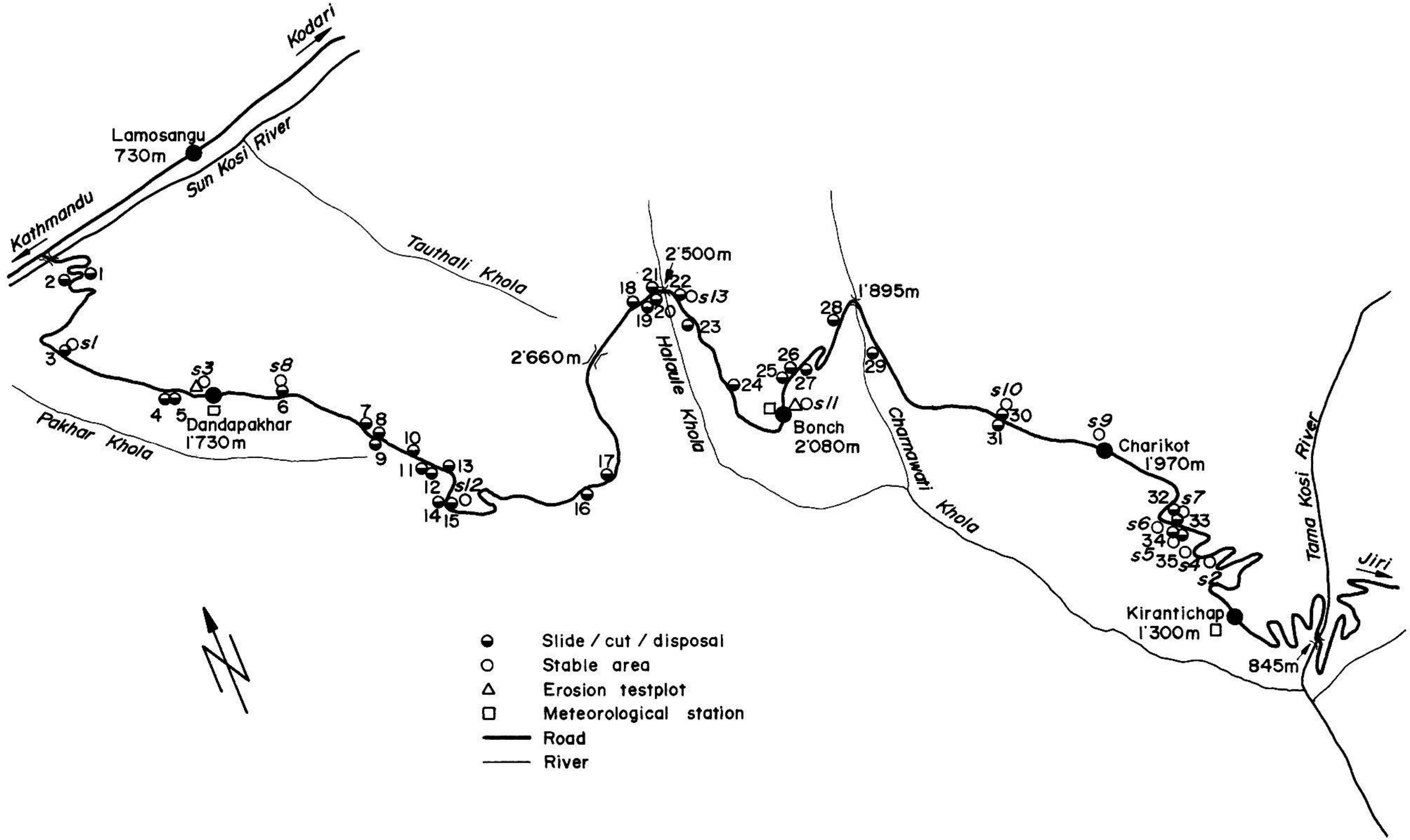


Fig. 3.1. Location of studied plots
Abb. 3.1. Lage der untersuchten Flächen

and after the monsoon (in September/October 1983, 1984 and 1985). A choice of nine of these slopes (Nos. 2, 4, 14, 16, 19, 24, 30 and 34) with quite well-developed plant cover was also checked after the dry season (in April 1984 and 1985).
The method of laying a transect consists in laying out a line which runs across the zone to be sampled and in placing quadrats at given intervals along the line. A frame of pins 10 cm long was used and orientated parallel to the transect at intervals of 20 cm. In each square of 10 cm it was noted which plant species occurred, but not how abundant they were, nor their size or age. The records of the squares of the transect or a section of it were added and the percental frequency was determined.
Theoretically, a transect is composed of an anchor (that is the relatively stable part on both sides of the landslide), the actual landslide and the transition between anchor and slide. Since an anchor or transition does not exist everywhere and the landslide may not be homogenous but composed of sections of a different age, it was not always possible in practice to lay the transects according to the above pattern. The placing of sections was provisionally fixed on site and was later revised according to the data collected by comparing plant occurrence in the "pufferung zone" (the semistable zone, where erosion is stopped, and which helps initiate further stabilization), as described for vegetation tables in MUELLER-DOMBOIS and ELLENBERG (1973).
Usually one horizontal transect per plot was laid. On plots 8, 22 and 33 two horizontal lines were recorded; on plot No. 19 one vertical and one horizontal line; on plots 1, 2 and 11 one vertical and two horizontal lines. The vertical transects give good homogenity for the slide section.

3.1.2. Evaluation

The large amount of data collected made it necessary to use a computer for the mathematical processing. The FORTRAN-IV program package described by WILDI and ORLOCI (1983) was used; the program names referred to are those used by these authors.
In view of the wide range of site factors and the heterogenity of vegetation it was first necessary to divide the plots into appropriate groups. This was done separately for the three sections, i.e. anchor,

transition and slide of the last postmonsoon records (October 1985), each section being treated as a relevé. Rare species occurring only once or twice were eliminated as were very abundant species occurring unspecifically over the whole study area, in order to clarify the group structure. The ordination co-ordinates of the relevés and species were computed by correspondence analysis (program PCAB). This allows a direct comparison of relevés with species and aids in assessing their interaction. The corresponding scatter diagram was printed (program ORDB).
By calculating the correlation coefficients (program RESE) the influence of the site factors could be determined. The following discriminant analysis (program DIAN) allowed confirmation of the group pattern and analysis of the discriminating power of the site factors for the relevé groups.
For each site group and its sections a minimum variance cluster analysis (program CLTR, using the cross product matrix of RESE) was computed in order to find species group structures. Then a frequency table was printed (program TABS).
In order to get a general idea of development trends and potential stabilization, the postmonsoon records of the years 1983, 1984, 1985 of each site group were compared. With the help of the correspondence analysis (program PCAB) and the following ordination (program ORDB) the respective scatter diagrams were printed. The points representing the same relevés were chronologically connected by arrows. From the same diagram the various successional stages of the sections can be noted. In addition, the data were processed by minimum variance cluster analysis and the corresponding tables were printed (program CLTR and TABS).
By the same method the records of the end of the dry season (April 1984 and 1985) and then those of the early monsoon (June 1984 and 1985) were computed for further comparison to confirm the findings of the postmonsoon records.

3.1.3. Stable Areas

The natural vegetation of relatively stable areas was recorded. They range from forest to shrubland to grassland or pasture. This gives additional knowledge of the floral composition of the study areas and allows a comparison with the plant occurrence in the three sections of the transects in the slopes and landslides of the study.

Table 3.2. The stable areas and their site charateristics
Tab. 3.2. Die intakten Gebiete mit ihren Standortsfaktoren

Stable area	Vegetation type	Altitude a.s.l.	Aspect 0-400°	Slope %	Location	Group No.
s1	xerophilous Pinus roxburghii-forest	1450	225	80	Thumpakhar	1
s2	xerophilous Pinus roxburghii-forest	1570	225	40	Daramghar	1
s3	shrubland	1700	225	65	Dandapakhar	2
s4	mesohygrophilous forest with Schima wall., Castanopsis ind., Rhododendron arb.	1710	300	60	Mati	2
s5	mesohygrophilous forest with Schima wall., Castanopsis ind., Rhododendron arb.	1730	250	80	Mati	2
s6	Eupatorium-shrubland	1740	200	35	Mati	2
s7	Eupatorium-shrubland	1750	175	70	Mati	2
s8	mesohygrophilous forest with Schima wall.	1820	250	75	Thulopakhar	2
s9	Imperata-pasture land	2050	150	30	Charikot	2
s10	Eupatorium-shrubland	2050	300	75	Makaibari	2
s11	grassland	2100	200	70	Bonch	2
s12a	hygrophilous forest with Daphniphyllum himalayense	2150	400	60	Shildhunga	3
b		2150	300	65		
c		2270	150	45		
d		2280	150	45		
s13	mesohygrophilous forest with Quercus semecarpifolia	2600	250	75	Halaule Khola	4

In 13 typical areas throughout the project region (Fig. 3.1, Table 3.2) the species present within a sample plot were listed, and to each species the following subjective assessments of abundance (simplified according to Braun-Blanquet's system of rating, compare e.g. KERSHAW 1973) were attached:

+ scarcely or only one present
1 covering less than 5% of the area
2 covering 5 to 25% of the area
3 covering 25 to 50% of the area
4 covering 50 to 75% of the area
5 covering 75 to 100% of the area.

Four layers were fixed: Trees (3-40 m), shrubs (1-3 m), herbs (0-1 m) and mosses.

The plots were characterized by their plant cover, site, altitude, bedrock, aspect, slope, size of area and influence of man (DOBREMEZ 1974b, KANAI et al. 1975).

3.1.4. Identification of Plants

The collected plants were identified in the National Herbarium of Nepal (Department of Medicinal Plants). Where it was uncertain the skilled staff made invaluable specifications. For the nomenclature the "Catalogue of Nepalese Vascular Plants" (MALLA 1976) of the same institute was used.

Since there is no moss-collection in the Herbarium in Nepal, the collected moss-species were brought to Switzerland. They were identified by Dr. Patricia Geissler in the Herbarium of Geneva.

3.2. SOIL

3.2.1. Soil Analysis

A mixed soil sample from the upper 20 cm of each anchor and slide of all the plots was taken. The 101 samples were air-dried and separated by

sieving. The 2 mm-fractions were sent to the Swiss Federal Research Station for Agronomy, Zürich. There the pH(H_2O)-value was measured and the content of phosphorus (P_2O_5) and potassium (K_2O) was analysed (in CO_2-saturated water, method of Dirks-Scheffer). The texture-class and humus-content of all the samples were estimated.
21 samples were further analysed for particle size distribution (sedimentation analysis) and organic carbon-content (wet incineration with potassium bichromate) and for 5 samples the cation exchange capacity was measured (in an exchange solution with an extraction mixture of 0.1N HCL and 0.05N H_2SO_4 1:1).

3.2.2. Soil Profile

Soil and bedrock-samples from each plot (slope/landslide/stable area) were examined. A rough division of the ground was made on site (rubble/unstabilized scree slope/technical stabilization/soil/rock).
On each site the soil profiles of the anchor and slide section were determined by boring a hole, observing structure, colour and consistency and measuring pH-value (Hellige) and presence of $CaCO_3$. The soils were characterized by comparing the profiles with those given in the soil study of ESPINOSA (1975), by using the nomenclature of FAO-UNESCO, Soil Map of the World (1974).

3.3. EROSION RESEARCH

3.3.1. The testplots

Soil and water loss is mainly influenced by rainfall (intensity and duration), vegetation cover, type of soil, inclination, length and shape of slope. To get individual storm runoff and soil loss data in the study region, two erosion control stations were installed.
The testplots at Dandapakhar (1730 m a.s.l.) (Figs. 3.2, 3.3) lie 200 m away from the meteorological station of IHDP and 15 m higher. They were under observation from May 1984 till October 1985. The two testplots lie

Fig. 3.2. The testplots at Dandapakhar on June 14, 1984
Abb. 3.2. Die Untersuchungsflächen in Dandapakhar am 14.6.1984

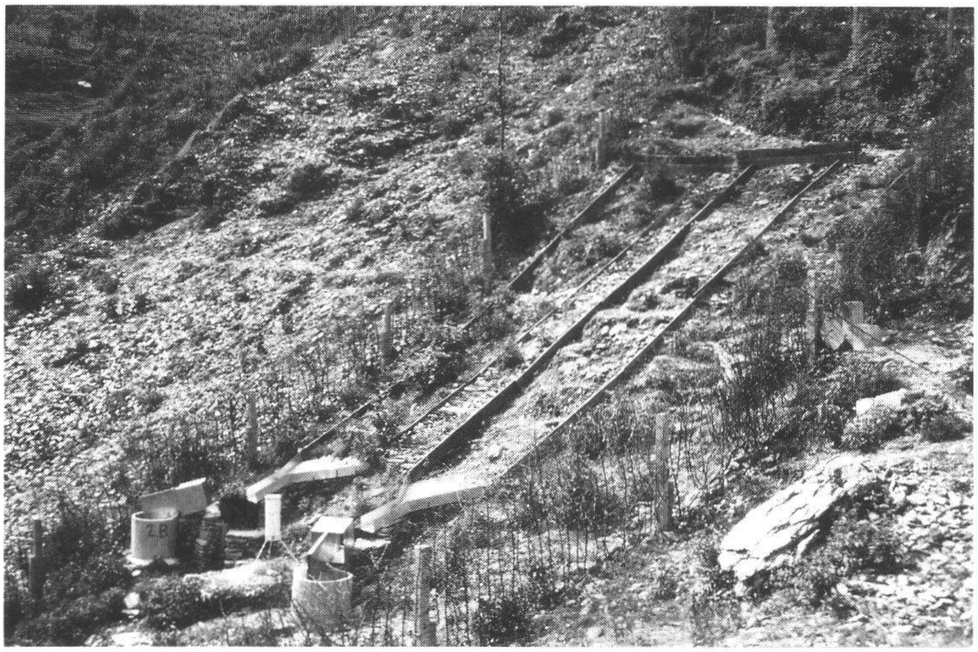


Fig. 3.3. The testplots at Dandapakhar on October 15, 1985
Abb. 3.3. Die Untersuchungsflächen in Dandapakhar am 15.10.1985

on a SSW-facing, 65% slope of an old landslide which was afforested with *Pinus roxburghii* by IHDP in 1983. The rock material of the slope consists of grey phyllitic schist and the rock dip lies nearly parallel to the slope surface. The whole landslide moved downwards about 1 m in September 1984 and is still moving slightly. Because of this downward shift the lower part of the overgrown plot was damaged and tank A was slightly tilted. This was repaired during the following dry season.

On the testplots at Bonch (2080 m a.s.l.) (Fig. 3.4) measurements were taken from April to October 1985. The site lies 250 m away from the meteorological station of IHDP and 50 m lower. It faces SSE on the well-covered 70% slope of an old gully. The whole area has been protected by a fence since 1980 as it belongs to an IHDP Subcenter. The bedrock consists of profoundly weathered schistoid gneiss (WAGNER 1983).

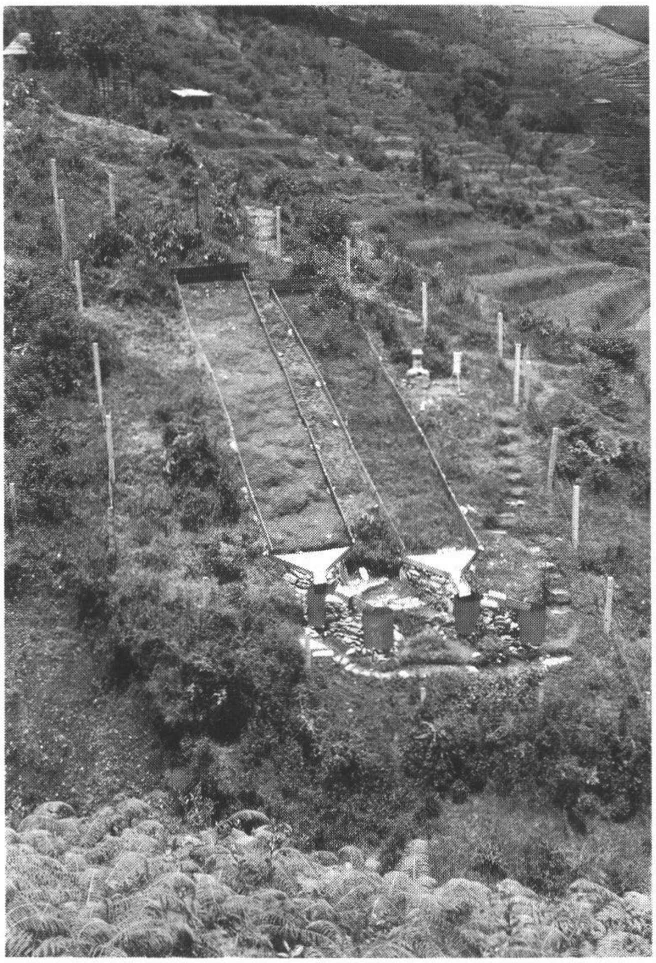


Fig. 3.4. The testplots at Bonch on August 5, 1985
Abb. 3.4. Die Untersuchungsflächen in Bonch am 4.8.1985

3.3.2. Experimental Design and Measurement

Of the common models available we chose to use that of the Soil Conservation Research Project in Ethiopia (SCRP 1984 and HURNI in prep.).
On both sites 2 plots of 20 m^2 (2 m wide and 10 m long) were bounded by wooden planks. One of the plots was left with its natural plant cover, the other one was totally weeded and weeding was repeated once a week. The plants of the overgrown testplot were recorded and on the plot at Dandapakhar the growing rate of the shrubs was measured. At Dandapakhar a choice of stones with a diameter of 5-10 cm were marked and their downward movement was measured. For protection a fence was built around the stations.
A recording raingauge was installed on both sites to measure the intensity of each storm, supported by a raingauge measuring only the total amount of rain as a control measure; these hand-measured data were also used when occasionally the recording raingauge was not working. With the recorded rainfall data the erosivity of each storm was calculated. According to WISCHMEIER and SMITH (1960, 1978) the erosivity indicates the

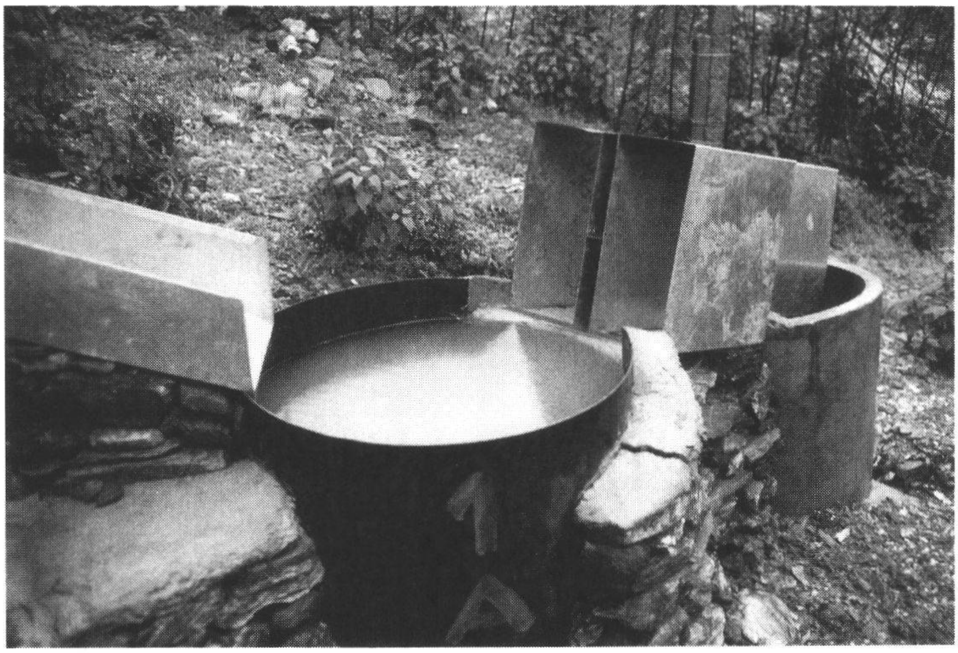


Fig. 3.5. Testplots Dandapakhar: Detail with tank A, overflow to tank B. 1.7.1984
Abb. 3.5. Untersuchungsflächen Dandapakhar: Detail mit Tank A und Ueberlauf zu Tank B. 1.7.1984

value of a storm which is proportional to soil loss on a bare soil continuously lying fallow caused by this storm. Therefore, rainfall erosity will not be proportional to the actual soil loss of a test plot, since vegetation cover, management practices, slope length and gradient are additionally influencing factors (HURNI 1982).
Runoff and sediment were collected into tank A (270 l capacity) through a channel at the lower end of each plot. For possible overflow from tank A a slot divisor, taking only 1/10 of the overflow, led to tank B (Fig. 3.5). After each storm or every morning following a rainy day the water in the testplot tanks was measured and 1-liter samples of tank A and - if there was overflow - of tank B were taken. The weight of the soil in tank A was measured and a soil sample of 500 g was taken (average variation of balance: 9%). The water samples were filtered. The filterpaper and the soil samples were dried for 24 hours at 60-100^{o}C, and the oven- dry weight of the soil contents measured (METTLER balance). The total soil loss and runoff were now calculated (for detailled sampling method and calculation see SCRP 1984, Vol. 1, pp. 30-32 and Appendix 3, and Vol. 2, Appendix 1 and 5).

4. RESULTS

4.1. VEGETATION

4.1.1. Landslides and slopes

The consequence of the diversity of site factors of the study area - especially the wide range of altitude - is a high vegetational heterogenity. A division of the plots into groups was therefore indispensable. Ordination and cluster analysis of the last survey (Sept./Oct. 1985), processed independently for the sections anchor, transition and slide (Figs. 4.1-4.6), showed a clear separation of a "high altitude group" and a fairly good separation of a "low altitude group". At the middle altitude other site factors than the altitude interfer. Among these the aspect seems to influence the vegetational composition noticeably. The following four groups were thus defined:

Group 1. Low altitude.
Plots 1-3 (transects 1-7) lie between 1100 and 1500 m in the lower sub-tropical belt (DOBREMEZ 1974a,b). Plot 1 and 2 have about the same altitude and both have a north-western aspect; plot 3 lies about 200 m higher and faces south (Fig. 4.7).
The anchor of plots 1 and 2 (transects 1-6) are composed of a mesohygrophilous forest with Schima wallichii, Castanopsis indica and Engelhardtia spicata. The trees and shrubs of No. 2 are frequently cut for fodder and firewood, and cows and goats feed there. The forest is thus reduced to shrubland. The anchor of No. 1 is in better condition due to protection by a fence built in 1982 by LJRP to give the severe landslide a chance to stabilize.
Plot No. 3 (transect No. 7) is situated in a xerophilous forest with mainly Pinus roxburghii, scarcely any underwood and a very short herb layer. To give the forest a chance to regenerate no pasturing or cutting of firewood has been allowed since 1982 (this interaction is to last for 7 years); but grass cutting is permitted. Thus the undershrub is steadily developing (for anchor of No. 3 see also stable area No. s1, for comparison stable area No. s2, Figs. 4.8, 4.9).

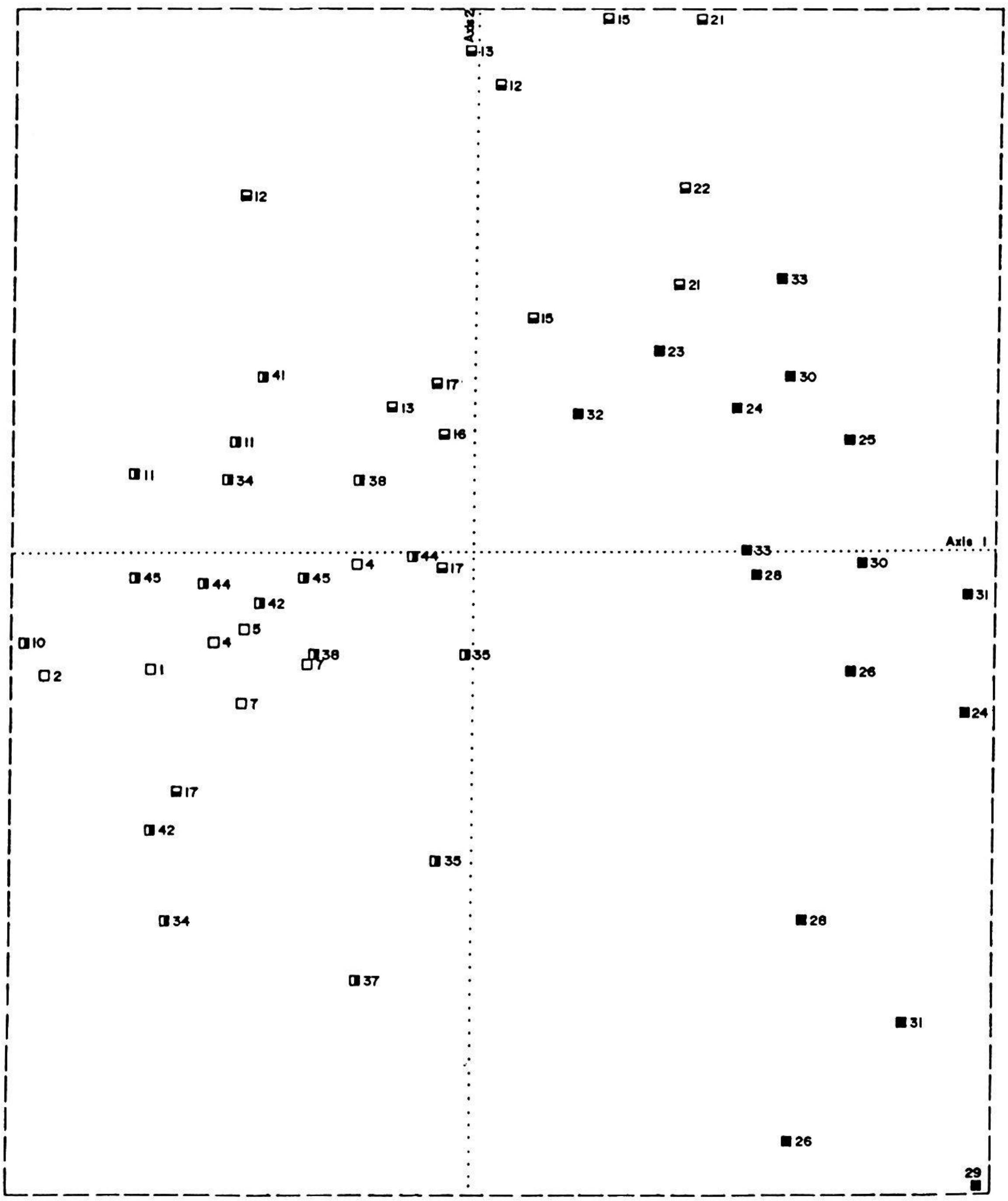


Fig. 4.1. Ordination of anchor sections, last survey (Oct. 1985):
Separation of four groups

Abb. 4.1. Ordination der Anker-Sektionen, letzte Aufnahme (Okt. 1985):
Einteilung in vier Gruppen

□ 4 = anchor group 1 with transect No.
◧ 37 = anchor group 2 with transect No.
⬓ 17 = anchor group 3 with transect No.
■ 29 = anchor group 4 with transect No.

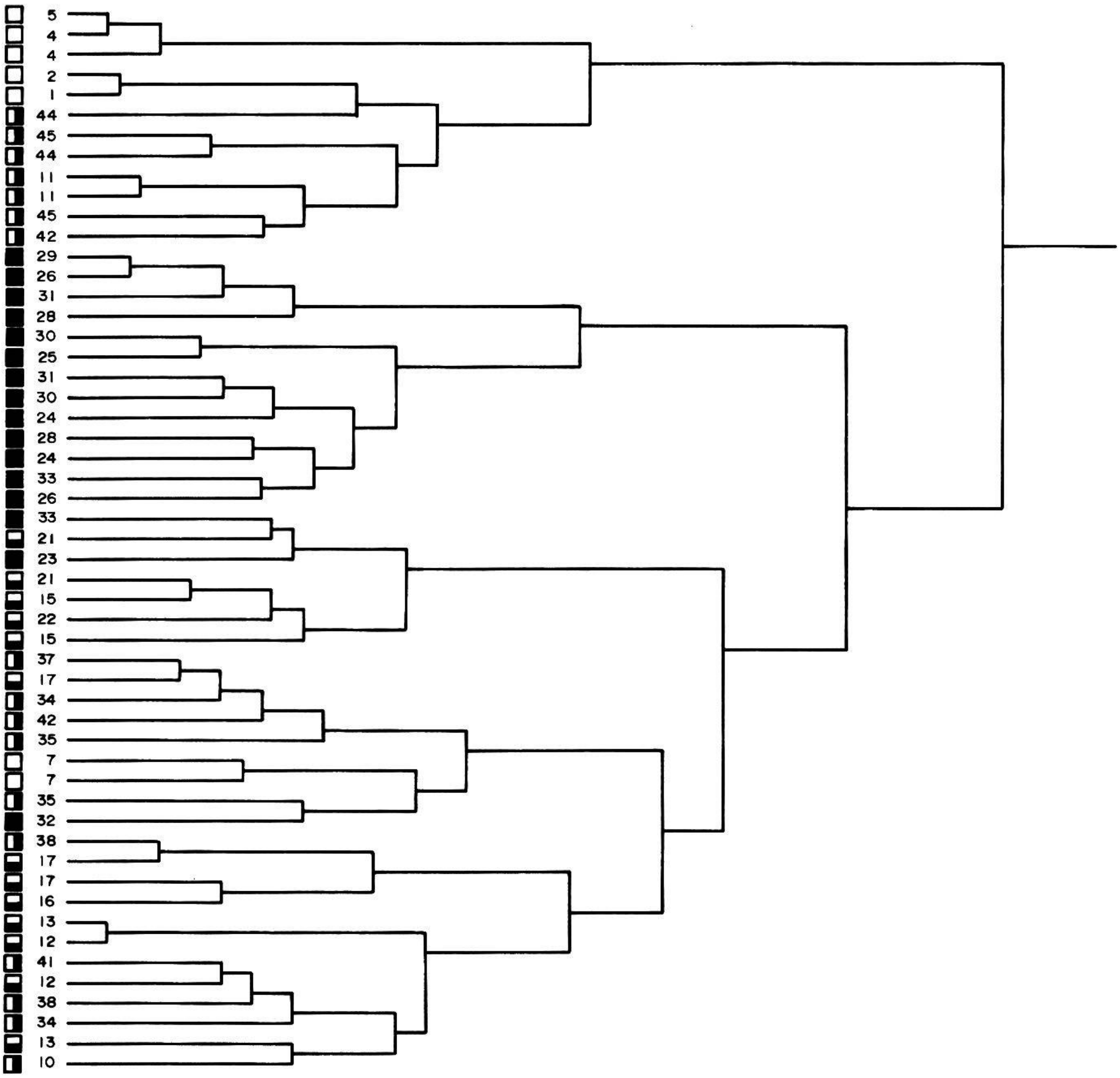


Fig. 4.2. Cluster analysis of anchor sections, last survey (Oct. 1985): Separation of four groups (for legend see Fig. 4.1)

Abb. 4.2. Dendrogramm der Anker-Sektionen, letzte Aufnahme (Okt. 1985): Einteilung in vier Gruppen (Legende siehe Abb. 4.1)

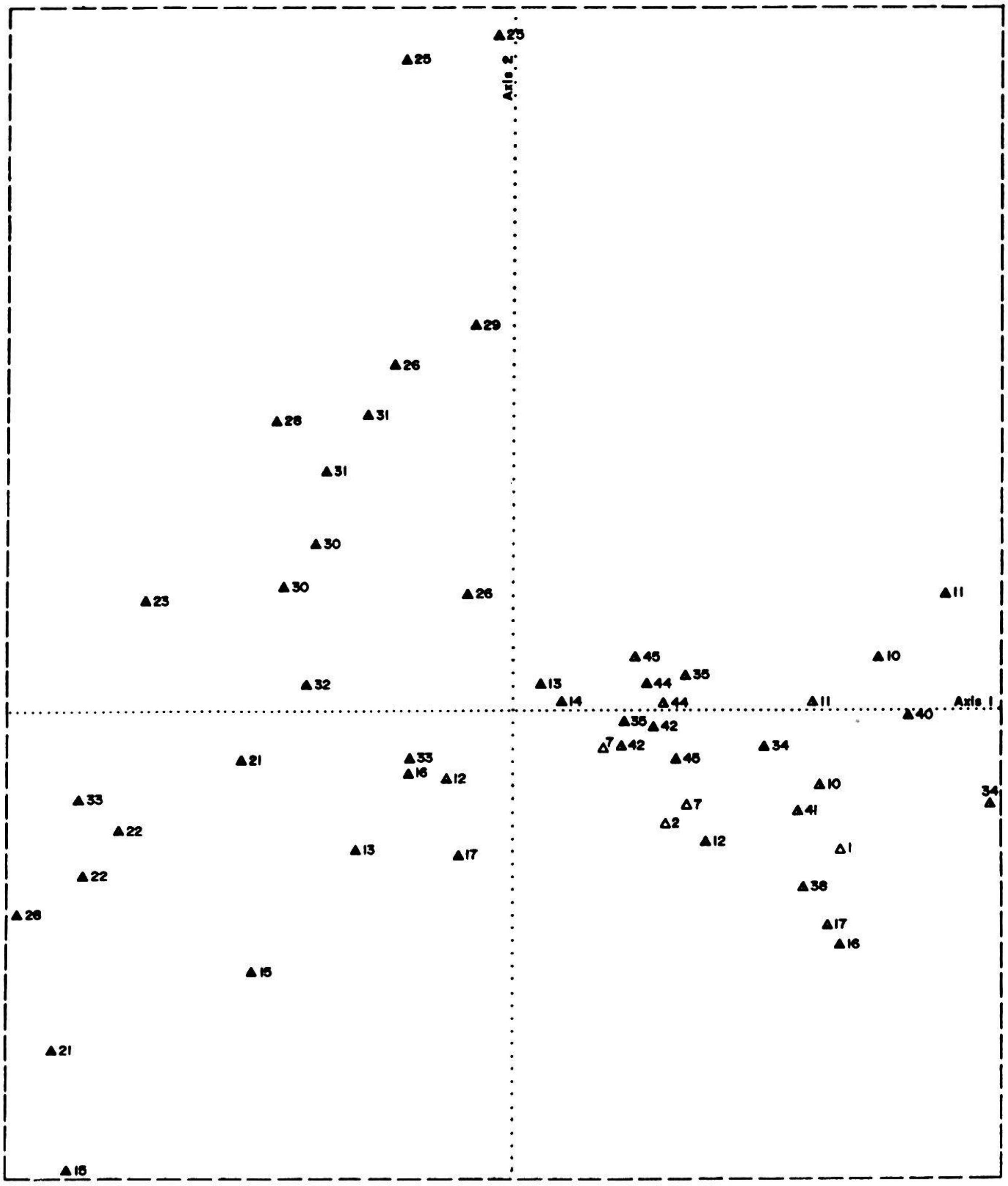


Fig. 4.3. Ordination of transition sections, last survey (Oct. 1985): Separation of four groups

Abb. 4.3. Ordination der Uebergangs-Sektionen, letzte Aufnahme (Okt. 1985): Einteilung in vier Gruppen

△ 7 = transition group 1 with transect No.
▲ 45 = transition group 2 with transect No.
▲ 12 = transition group 3 with transect No.
▲ 26 = transition group 4 with transect No.

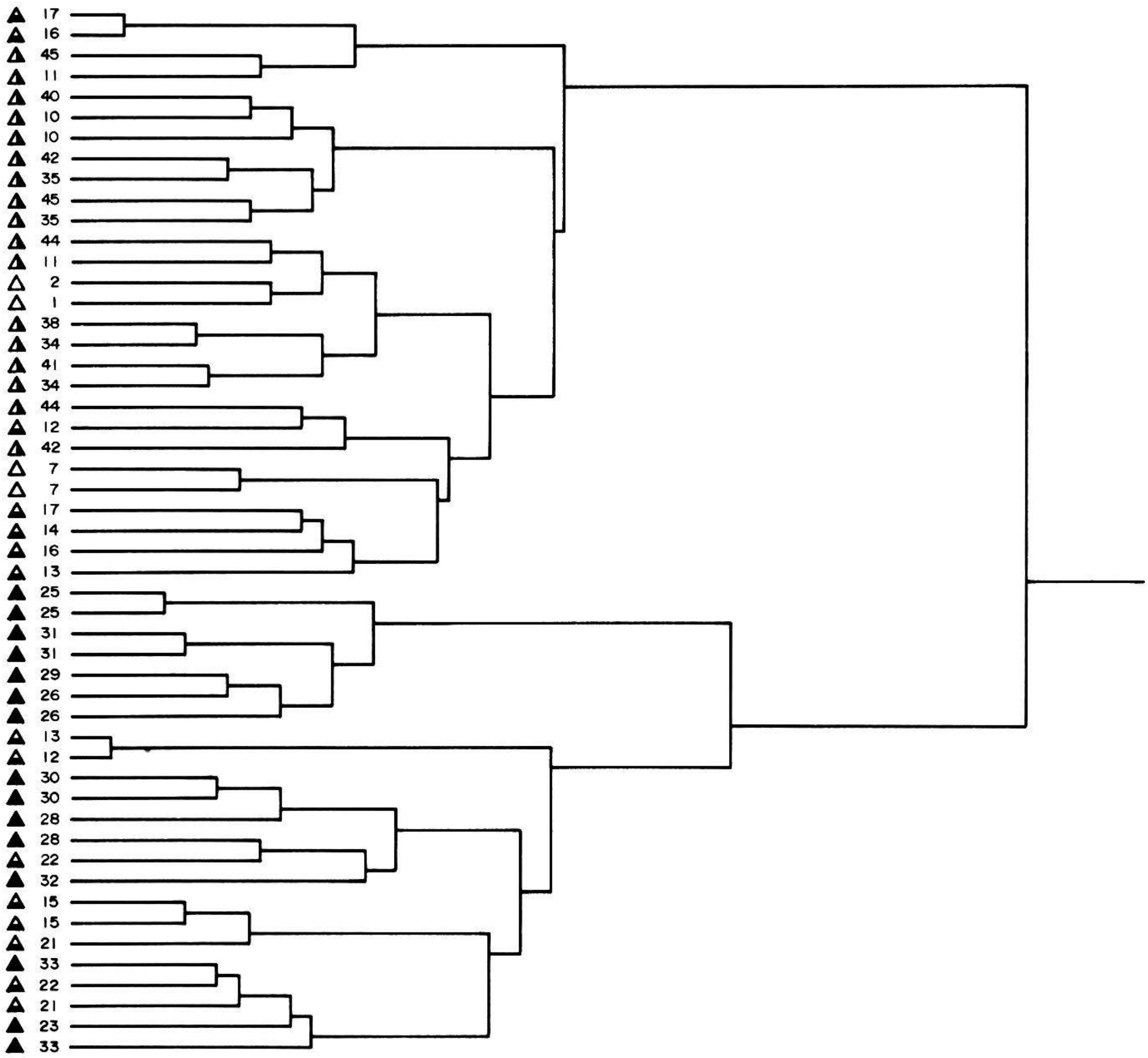


Fig. 4.4. Cluster analysis of transition sections, last survey (Oct. 1985): Separation of four groups (for legend see Fig. 4.3)

Abb. 4.4. Dendrogramm der Uebergangs-Sektionen, letzte Aufnahme (Okt. 1985): Einteilung in vier Gruppen (Legende siehe Abb. 4.3)

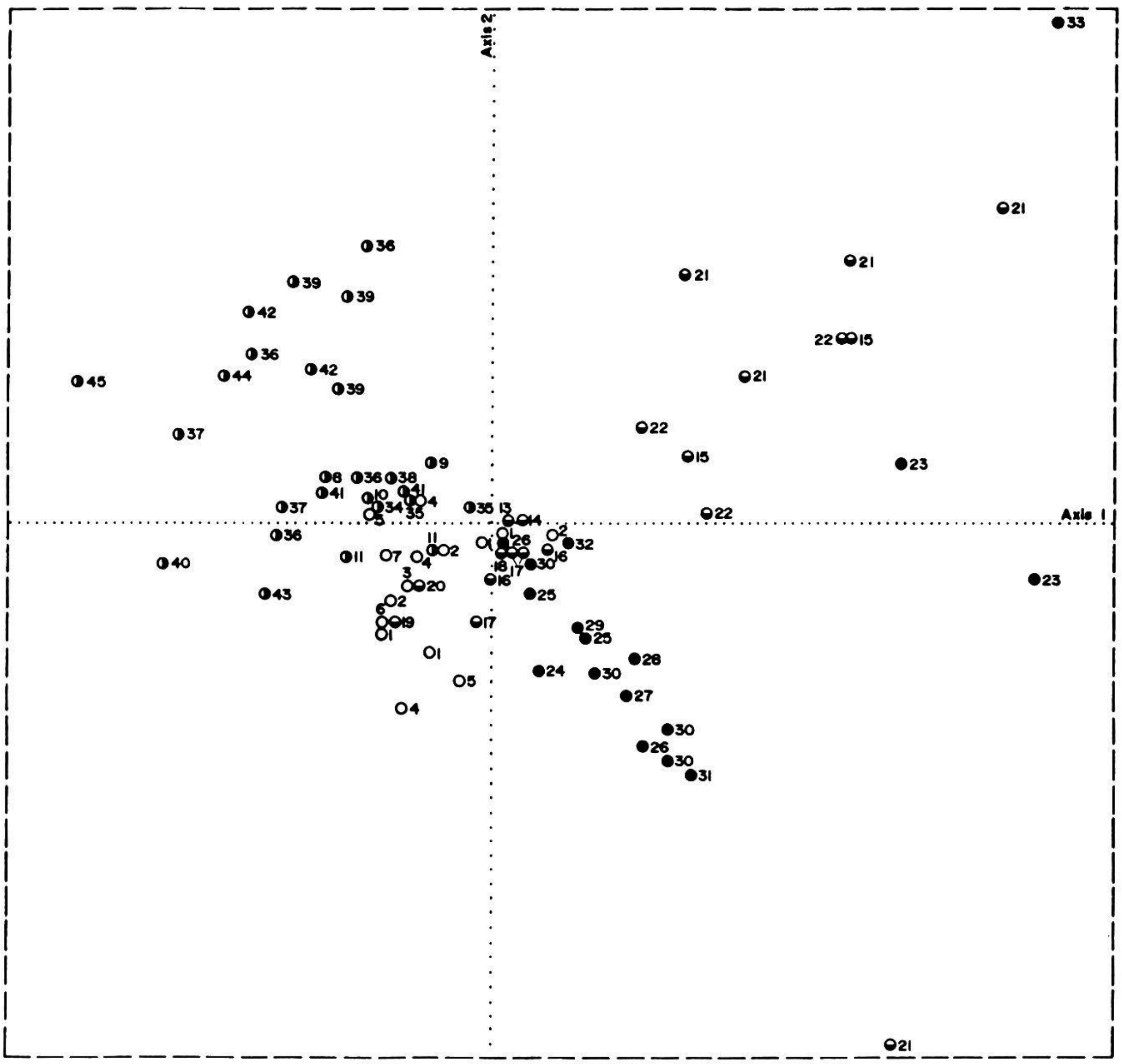


Fig. 4.5. Ordination of slide sections, last survey (Oct. 1985): Separation of four groups

Abb. 4.5. Ordination der Rutsch-Sektionen, letzte Aufnahme (Okt. 1985): Einteilung in vier Gruppen

○ 4 = slide group 1 with transect No.
◑ 36 = slide group 2 with transect No.
⊖ 22 = slide group 3 with transect No.
● 31 = slide group 4 with transect No.

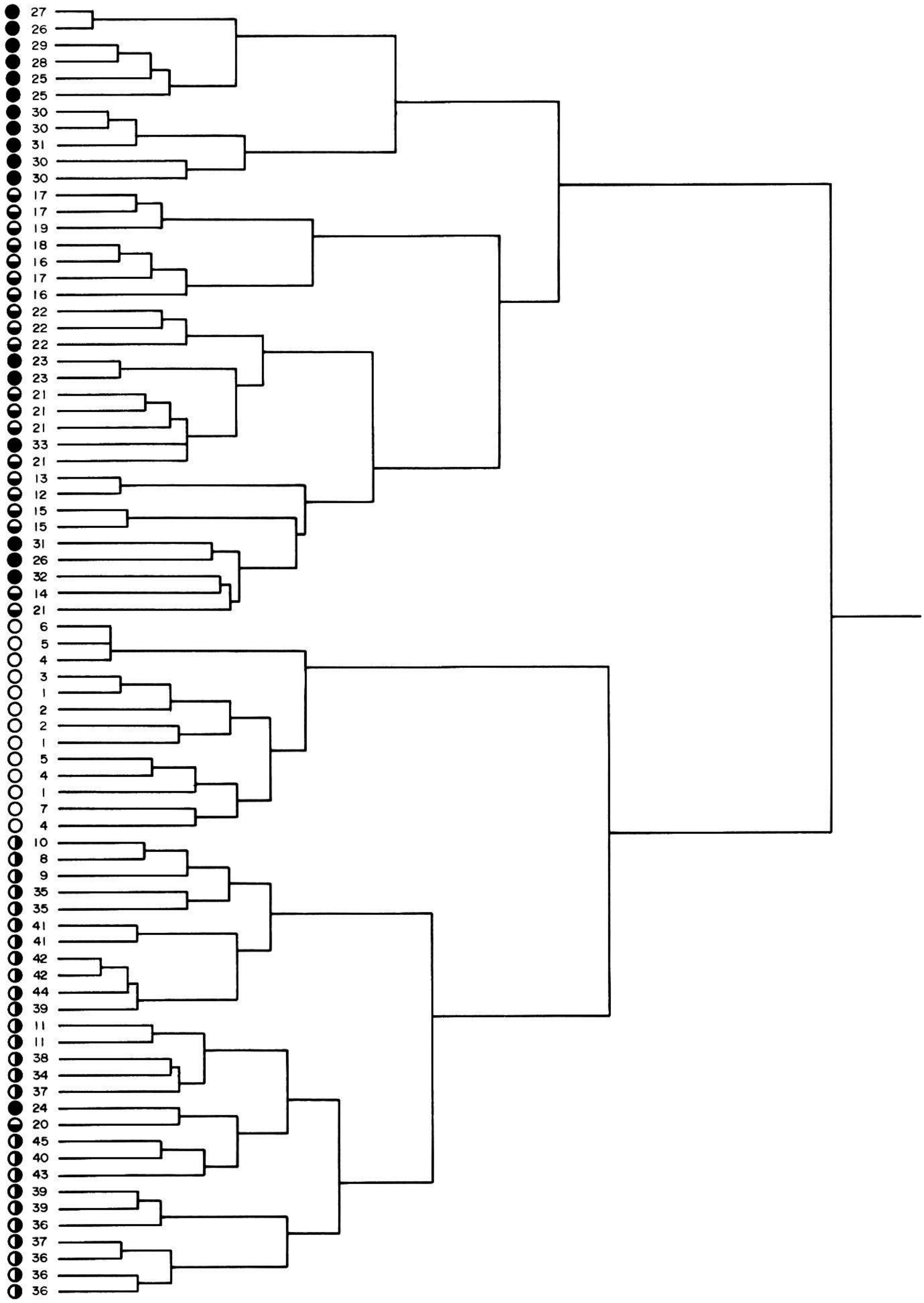

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Fig. 4.7. Study plot 3, transect 7. Anchor in Pinus roxburghii-forest (stable area sl). 27.10.1983

Abb. 4.7. Untersuchungsfläche 3, Transekt 7. Anker in Pinus roxburghii-Wald (intaktes Gebiet sl). 27.10.1983

Fig. 4.6 (p. 36). Cluster analysis of slide sections, last survey (Oct. 1985): Separation of four groups (for legend see Fig. 4.5)

Abb. 4.6 (S. 36). Dendrogramm der Rutsch-Sektionen, letzte Aufnahme (Okt. 1985): Einteilung in vier Gruppen (Legende siehe Abb. 4.5)

Fig. 4.8. Stable area s2. Xerophilous Pinus roxburghii-forest. 27.9.1984

Abb. 4.8. Intaktes Gebiet s2. Xerophiler Pinus roxburghii-Wald. 27.9.1984

Plant composition and frequency of the species for the last survey of group 1 are shown in Table 4.1 (in the pocket of the cover). As a sample for this group, Fig. 4.10 displays a rough map of study plot No. 1 with its transects and sections.

Group 2. Lower middle altitude with a generally southern aspect.

Plots 4-7 and 25-35 (transects 8-11 and 34-45) lie in the upper subtropical belt (DOBREMEZ 1974a,b) between 1600 and 2100 m. The change from the lower subtropical belt is gradual. This area is considerably overexploited.

Plot No. 4 (transect No. 8), protected by a fence by LJRP for stabilization, and plot No. 5 (transect No. 9) are situated in cultivated but poor land, the neighbouring terraces lying fallow during the time of the study. On steep or rocky slopes also found in this area only shrubby vegetation survives (for composition of this vegetation see stable area No. s3).

Plot No. 6 (transect No. 10) (Figs. 4.11, 4.12) lies in what little remains of a mesohygrophilous Schima wallichii forest with a few Lyonia ovalifolia and a well developed shrub layer (see stable area No. s8, Fig. 4.13).

Plot No. 7 (transect No. 11) is a landslide in an afforested area (IHDP afforestation of the whole hill-range since 1975) with Pinus patula (seeds from Kenya) and a very good regeneration of Schima wallichii, Engelhardtia spicata, Eurya acuminata, Myrica esculenta, etc.

Plots 25-33 (transects 34-43) (Figs. 4.14-4.17) are situated in a very cultivated area with practically no forest. In gullies or on slopes Alnus nepalensis is abundant besides the usual shrubby vegetation with mainly Pyrus pashia, Berberis aristata, Osbeckia nepalensis, Phyllanthus parvifolius, Hypericum cordifolium, Eupatorium adenophorum, etc. (see also stable areas s6, s7 and s9-s11).

Fig. 4.9 (p. 38). Stable area s2: Detail of herb layer. 27.9.1984
Abb. 4.9 (S. 38). Intaktes Gebiet s2: Ausschnitt aus der Krautschicht. 27.9.1984

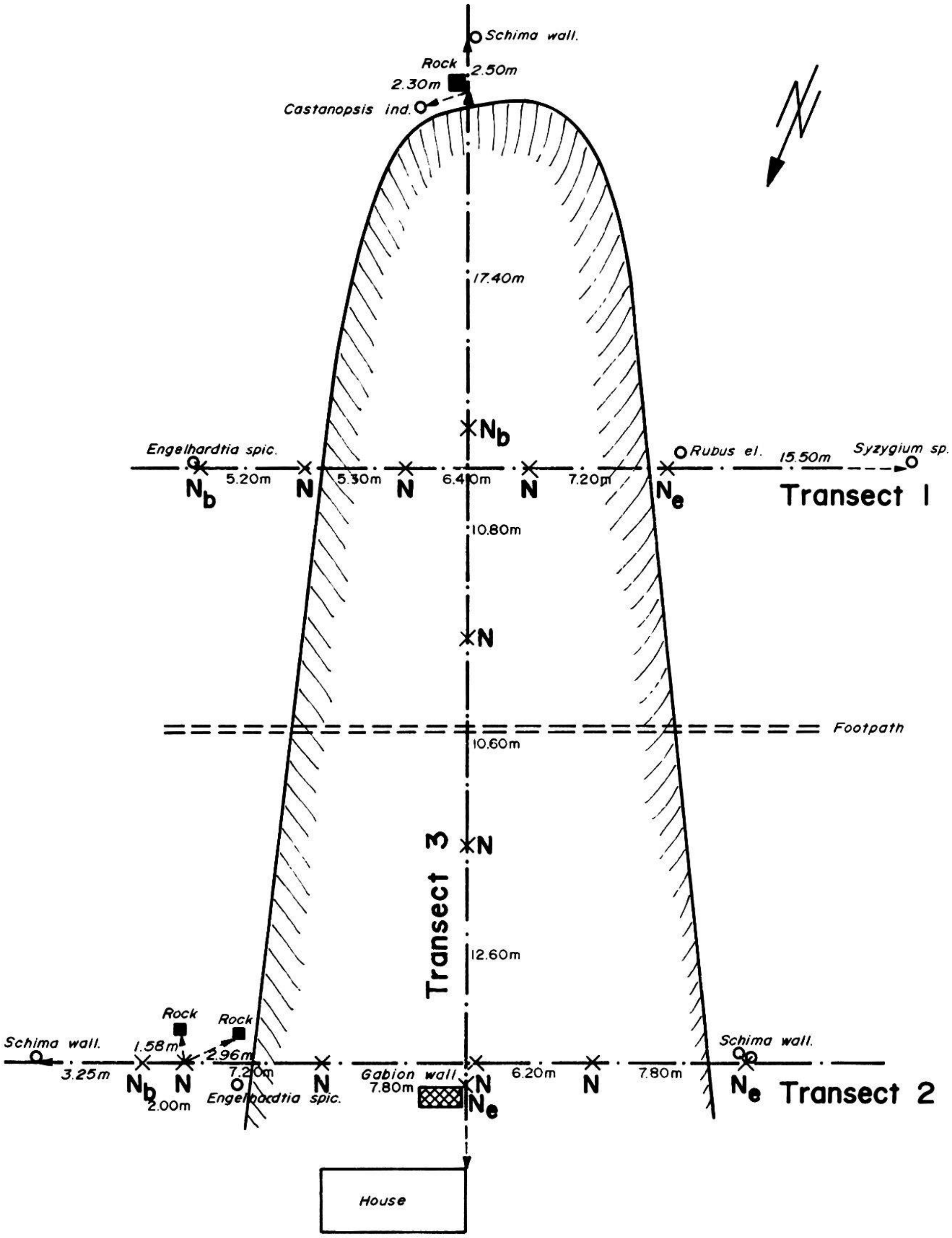


Fig. 4.10. Study plot 1 (not to scale)
Abb. 4.10. Untersuchungsfläche 1 (nicht massstäblich)

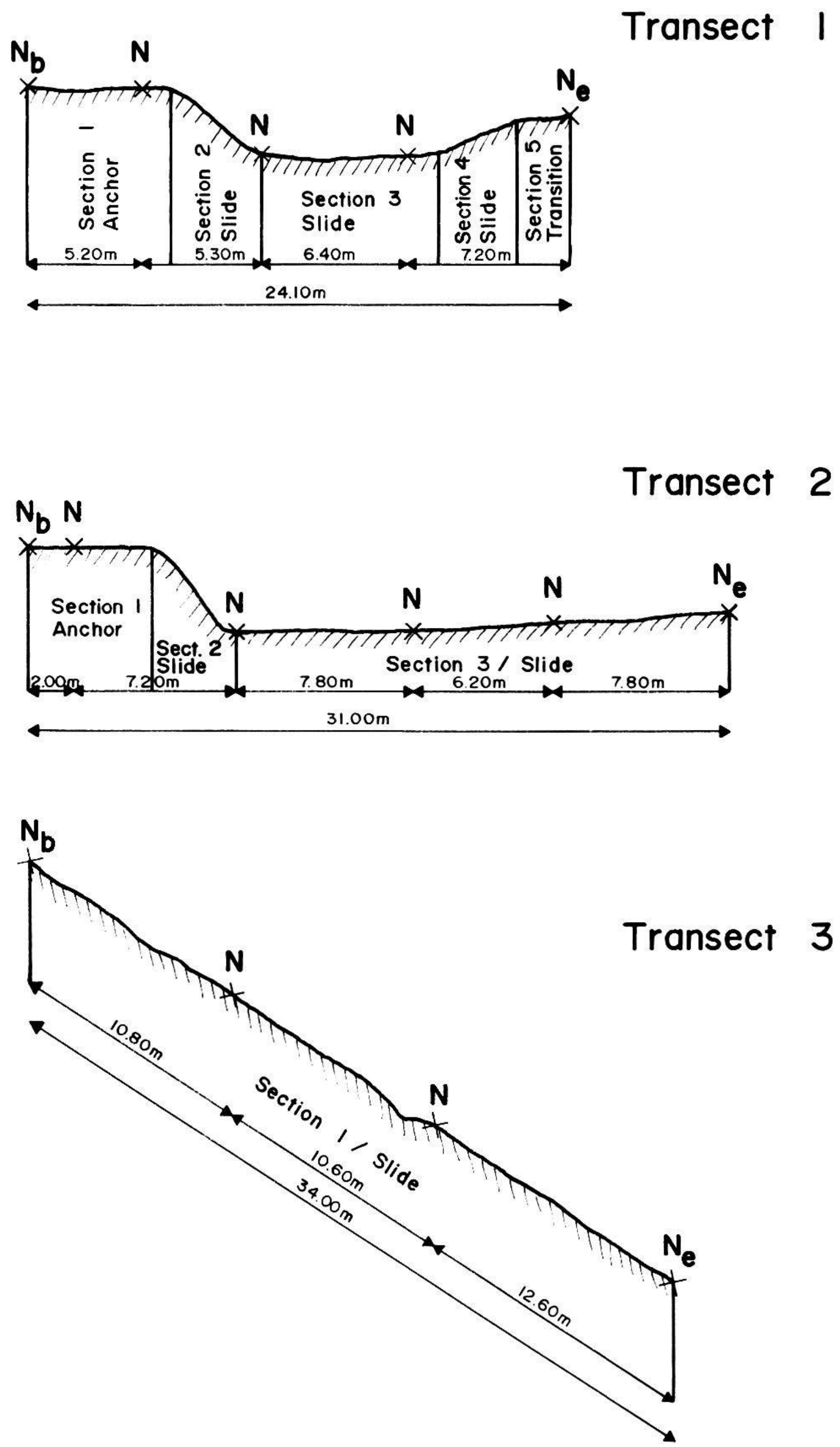


Fig. 4.10 (continued)

N = fixed iron nail
N_b = fixed iron nail, beginning of transect
N_e = fixed iron nail, end of transect

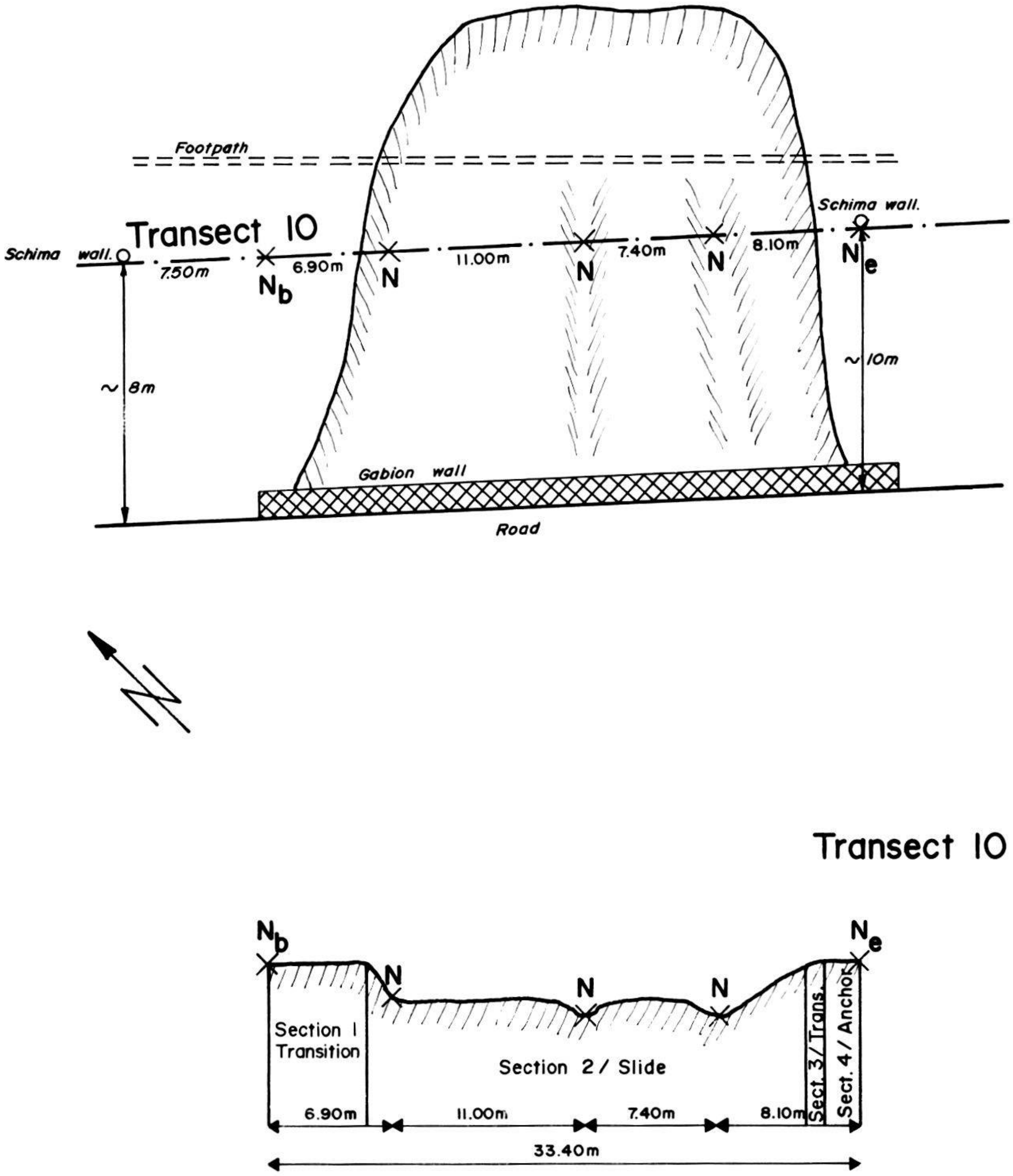


Fig. 4.11. Study plot 6 (not to scale) (for legend see Fig. 4.10)
Abb. 4.11. Untersuchungsfläche 6 (nicht massstäblich) (Legende siehe Abb. 4.10)

Fig. 4.12. Study plot 6, transect 10. Anchor in Schima wallichii-forest (stable area s8). 26.10.1983

Abb. 4.12. Untersuchungsfläche 6, Transekt 10. Anker in Schima wallichii-Wald (intaktes Gebiet s8). 26.10.1983

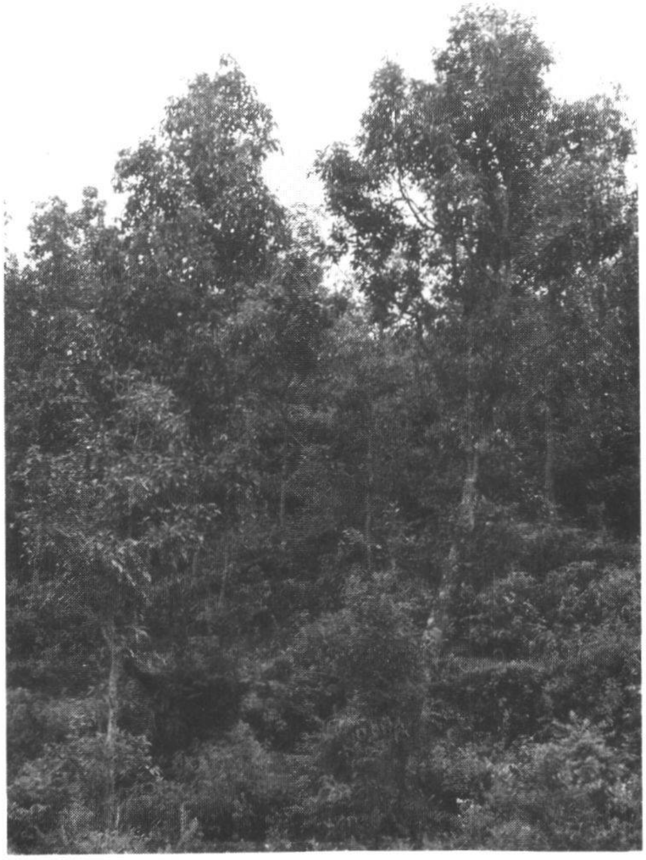


Fig. 4.13. Stable area s8. Mesohygrophilous forest with Schima wallichii. 16.10.1985

Abb. 4.13. Intaktes Gebiet s8. Mesohygrophiler Wald mit Schima wallichii. 16.10.1985

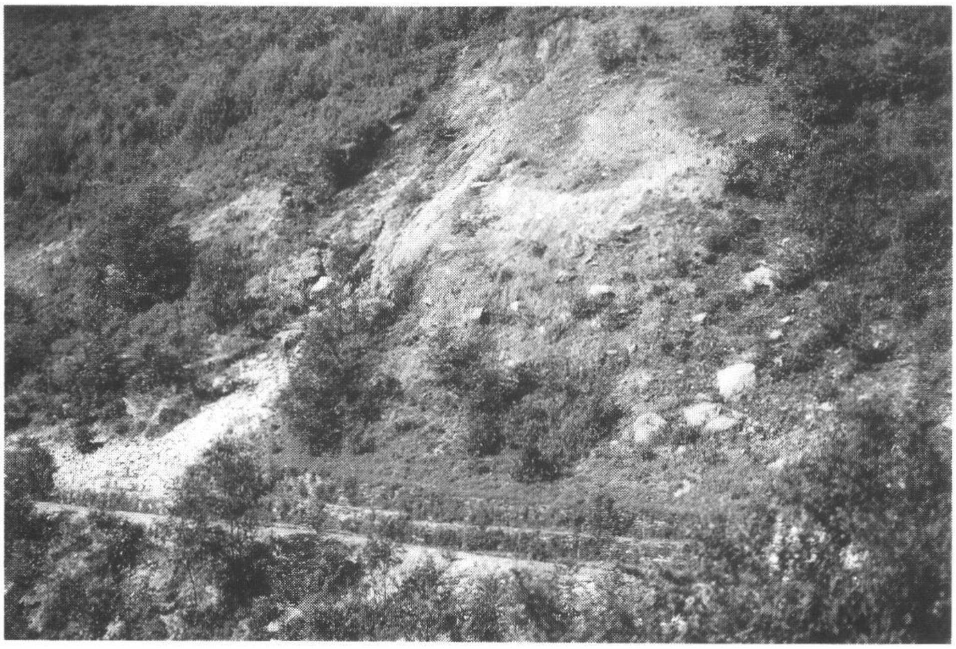


Fig. 4.14. Study plot 26, transect 35. Anchor in shrubland. 8.10.1984
Abb. 4.14. Untersuchungsfläche 26, Transekt 35. Anker in Buschland. 8.10.1984

Fig. 4.15. Study plot 27, transect 37. Planted with Alnus nepalensis; Saccharum spontaneum in flower. 17.10.1983
Abb. 4.15. Untersuchungsfläche 27, Transekt 37. Bepflanzt mit Alnus nepalensis; Saccharum spontaneum im Vordergrund blühend. 17.10.1983

Plots 34 and 35 (transects 44 and 45) (Fig. 4.18) lie in a mesohygrophilous forest with Schima wallichii, Castanopsis indica, Engelhardtia spicata, Lyonia ovalifolia, Rhododendron arboreum, etc. (see stable areas s4 and s5, Figs. 4.19, 4.20). This forest still exists, although considerably exploited.
Plant composition and frequencies of the last survey of group 2 are shown in Table 4.2 (in the pocket of the cover) and as a sample study plot No. 6 with its transects and sections is sketched in Figure 4.11.

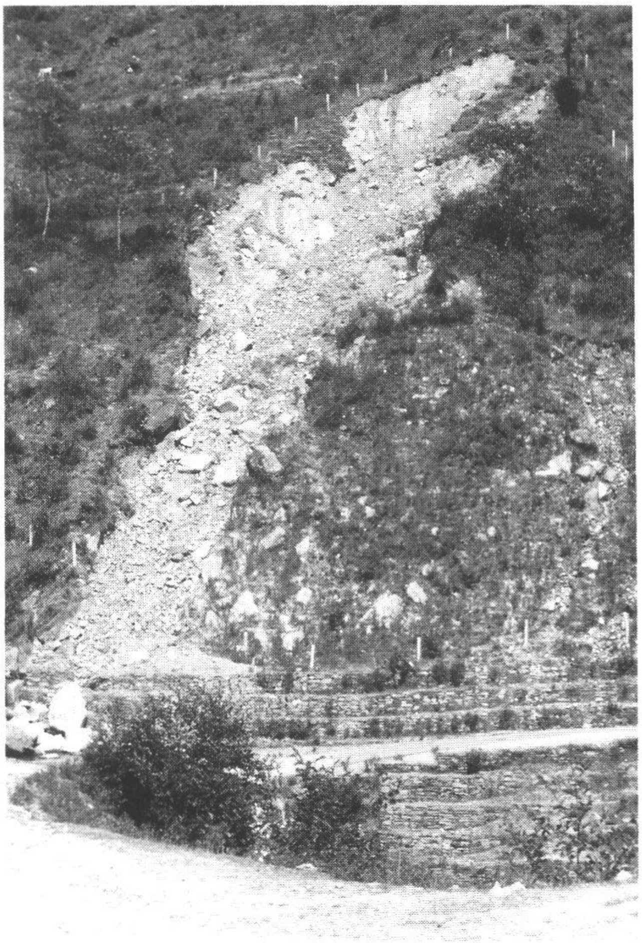


Fig. 4.16. Study plot 28, transect 38. Anchor in shrubland with Alnus nepalensis. 17.10.1983
Abb. 4.16. Untersuchungsfläche 28, Transekt 38. Anker in Buschland mit Alnus nepalensis. 17.10.1983

Group 3. Higher middle altitude with a generally northern aspect.

Plots 8-15 (transects 12-22) (Figs. 4.21-4.24) lie between 1900 and 2200 m, i.e. in the upper subtropical belt, advancing into the middle hill belt (DOBREMEZ 1974a,b). The northern aspect enables some forests to survive.

The anchor vegetation of plots 8-13 (transects 12-20) varies between shrubland and hygrophilous forest with Alnus nepalensis, Eurya acuminata, Myrsine semiserrata, Berberis aristata, B. asiatica, Rubus ellipticus, etc.

Plots 11 and 12 (transects 16-19) face south or southwest and could be defined as a subgroup as they have a high pH-value. They are the only plots were $CaCO_3$ was found in the soil. The presence of Polygala triphylla and to some extent Eulalia mollis seems to be related to this.

Plots 14 and 15 (transects 21 and 22) are situated in an area covered with a reasonably intact hygrophilous forest with Daphniphyllum himalayensis dominating, accompanied by Alnus nepalensis, Lyonia ovalifolia, Eurya and Symplocos species etc. (see stable areas s12a-s12d, Fig. 4.25). A large part of this forest has been protected by an IHDP-fence since 1981, no grazing or cutting of firewood having been allowed.

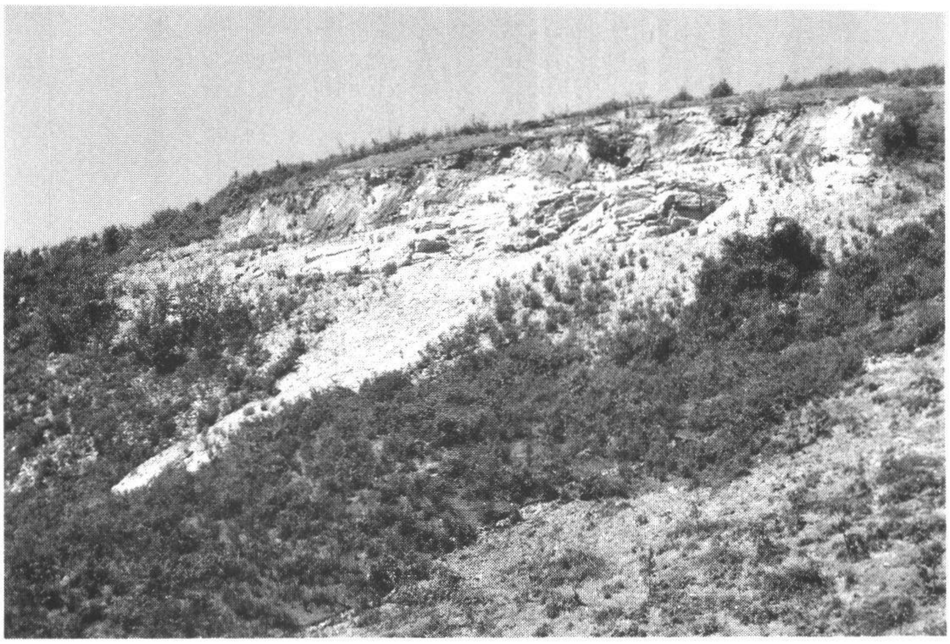


Fig. 4.17. Study plot 32, transect 42. Anchor in Eupatorium-shrubland (stable area s7). 2.10.1984

Abb. 4.17. Untersuchungsfläche 32, Transekt 42. Anker in Eupatorium-Buschland (intaktes Gebiet s7). 2.10.1984

The floral composition and plant frequencies of the last survey of group 3 are given in Table 4.3 (in the pocket of the cover). Figure 4.26 shows a sketch of study plot No. 15 as a sample for this group.

Group 4. High altitude.

Plots 16-24 (transects 23-33) are situated in the middle hill belt between 2300 and 2600 m (DOBREMEZ 1974a,b). The pastures and forests are much exploited, the trees, especially Quercus semecarpifolia, being heavily lopped.

The plots 16-21 (transects 23-29) (Figs. 4.27, 4.28) lie in pasture land with Hemiphragma heterophyllum, Potentilla fulgens, Arundinella hookeri, Agrostis pilosula, Arthraxon lancifolius und Carex sp. as main representatives of the herb layer.

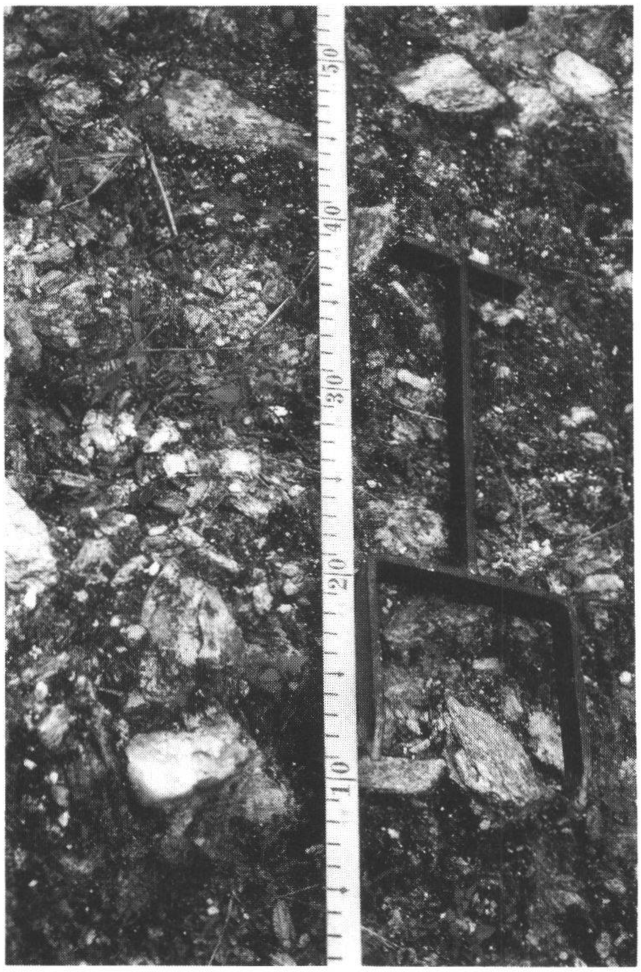


Fig. 4.18. Study plot 35, transect 45: Detail of slide section. 17.6.1984

Abb. 4.18. Untersuchungsfläche 35, Transekt 45: Ausschnitt aus der Rutsch-Sektion. 17.6.1984

The anchor of plots 22-24 (transects 30-33) (Figs. 4.29-4.31) consist of mesohygrophilous forest with Quercus semecarpifolia, Pieris formosa, Rhododendron arboreum and Symplocos species (see also stable area No. s13).

The floral composition and plant frequencies of the last survey of group 4 are shown in Table 4.4 (in the pocket of the cover); Figure 4.32 outlines study plot No. 19 as representative for this group.

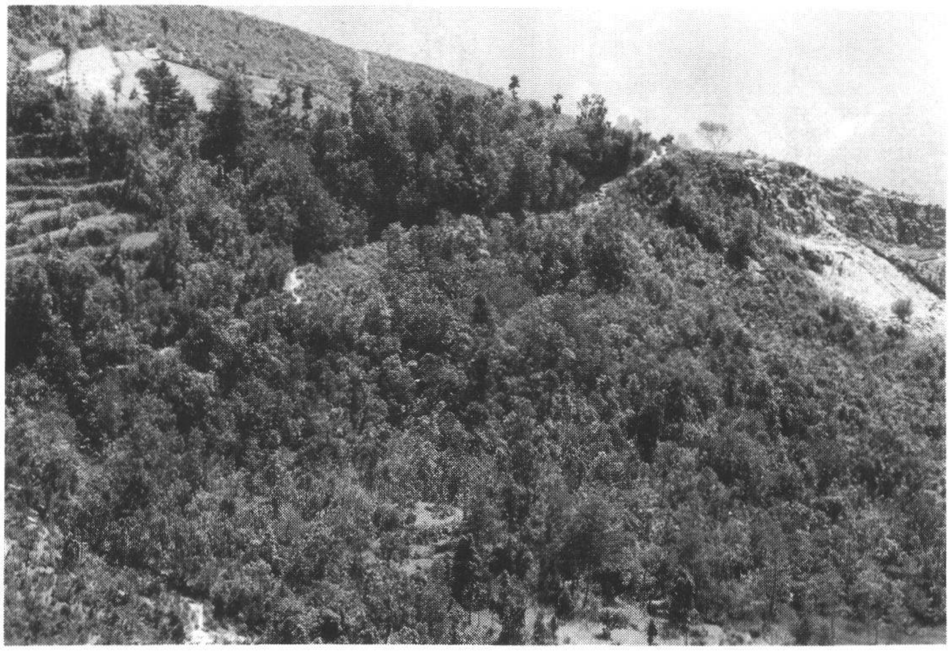


Fig. 4.19. View of stable area s4. Mesohygrophilous forest with Schima wallichii, Castanopsis indica, Rhododendron arboreum. 2.10.1984

Abb. 4.19. Blick auf das stabile Gebiet s4. Mesohygrophiler Wald mit Schima wallichii, Castanopsis indica, Rhododendron arboreum. 2.10.1984

Fig. 4.20 (p. 49). Stable area s4: Detail of mesohygrophilous forest. 27.9.1984

Abb. 4.20 (S. 49). Stabiles Gebiet s4: Ausschnitt aus dem mesohygrophilen Wald. 27.9.1984

Fig. 4.21 (p. 49). Study plot 9, transect 14. Alnus nepalensis growing in foreground. 14.10.1984

Abb. 4.21 (S. 49). Untersuchungsfläche 9, Transekt 14. Im Vordergrund mit Alnus nepalensis. 14.10.1984

Fig. 20 (see legend p. 48)

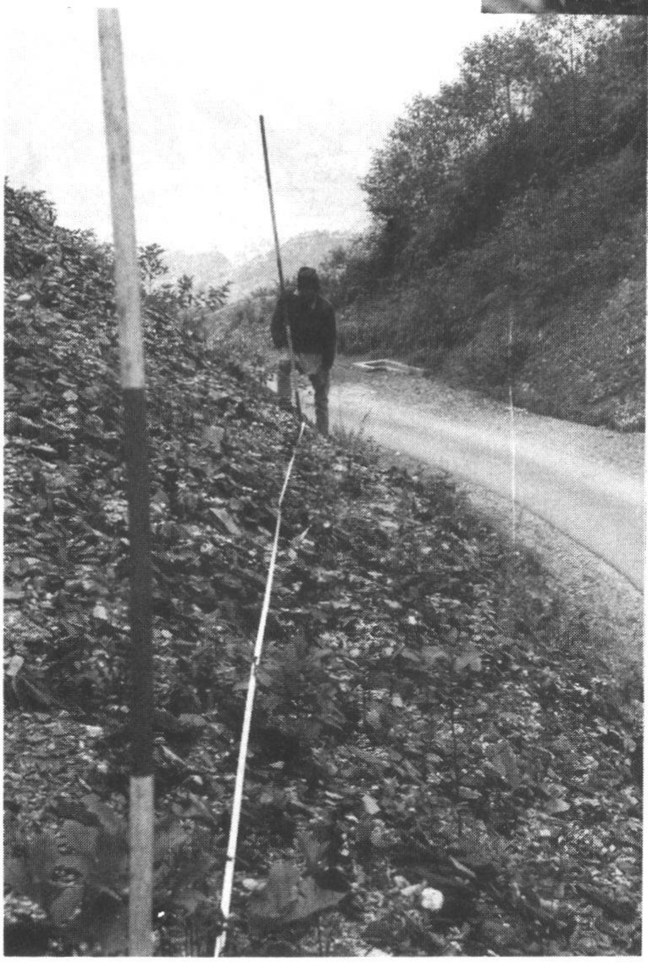


Fig. 21 (see legend p. 48)

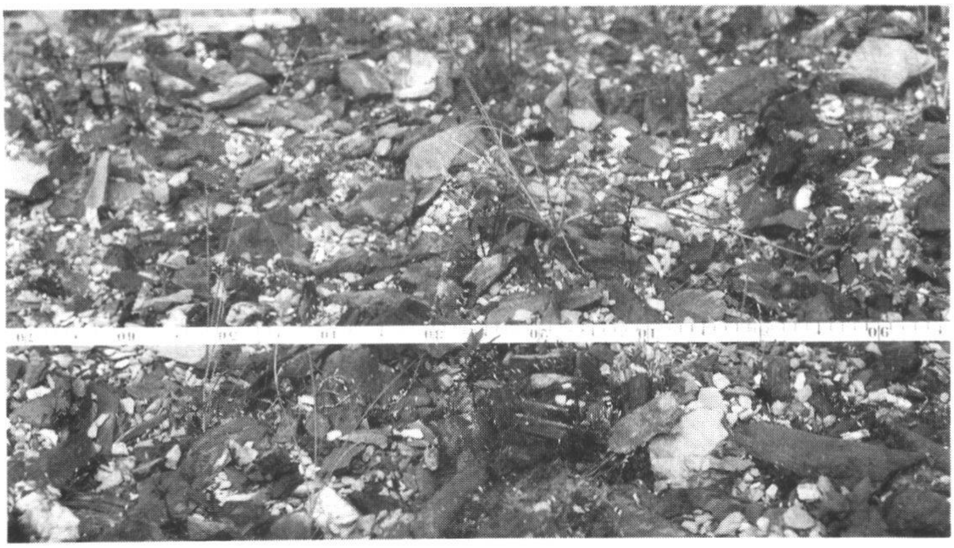


Fig. 4.22. Study plot 9, transect 14: Detail of slide section on lithosol. 14.10.1984

Abb. 4.22. Untersuchungsfläche 9, Transekt 14: Ausschnitt aus der Rutsch-Sektion auf Lithosol. 14.10.1984

Fig. 4.23. Study plot 11, transect 18 (vertical). 24.10.1983

Abb. 4.23. Untersuchungsfläche 11, Transekt 18 (vertikal). 24.10.1983

Fig. 4.24. Study plot 14, transect 21. Anchor in hygrophilous Daphniphyllum himalayense-forest (stable area s12). 12.10.1984
Abb. 4.24. Untersuchungsfläche 14, Transekt 21. Anker in hygrophilem Daphniphyllum himalayense-Wald (intaktes Gebiet s12). 12.10.1984

4.1.2. Stable areas

The monsoon climate promotes the development of a rich flora (DOBREMEZ 1976, KANAI et al. 1975, POLUNIN and STAINTON 1984). The records of some relatively stable areas, ranging from grassland or pasture to shrubland and forest, illustrate this well.
A list of the 13 stable areas recorded, their site factors and their characteristic plant society is given in Table 3.2. These stable areas are also related to groups 1-4 of the landslides and slopes according to the vegetation zonation scheme of DOBREMEZ (1974b). In Table 4.5 (in the pocket of the cover) the abundance of the species in the stable areas is noted.

The plots s9 and s11 (Fig. 3.4) lie in grassland. No. s9 is grazed on regularly; Imperata cylindrica and to some extent Schizachyrium brevifolium dominate. On No. s11, which has not been grazed but only cut since 1980, there is much Imperata and Schizachyrium, and Arundinella nepalensis, Sacciolepis indica and Sporobolus piliferus are also abundant. The plot is on the whole much richer in species.
The areas s3, s6, s7 and s10 (Figs. 3.2, 3.3, 4.17) represent shrubland with Eupatorium adenophorum dominating besides Phyllanthus parvifolius and Osbeckia stellata. Some Pyrus pashia may develop, or even Schima wallichii as on No. s3. This plot was in poor condition in March 1984; but after being fenced as a testplot for erosion control in April 1984, it developed quickly, which can be noted by comparing the fenced plot

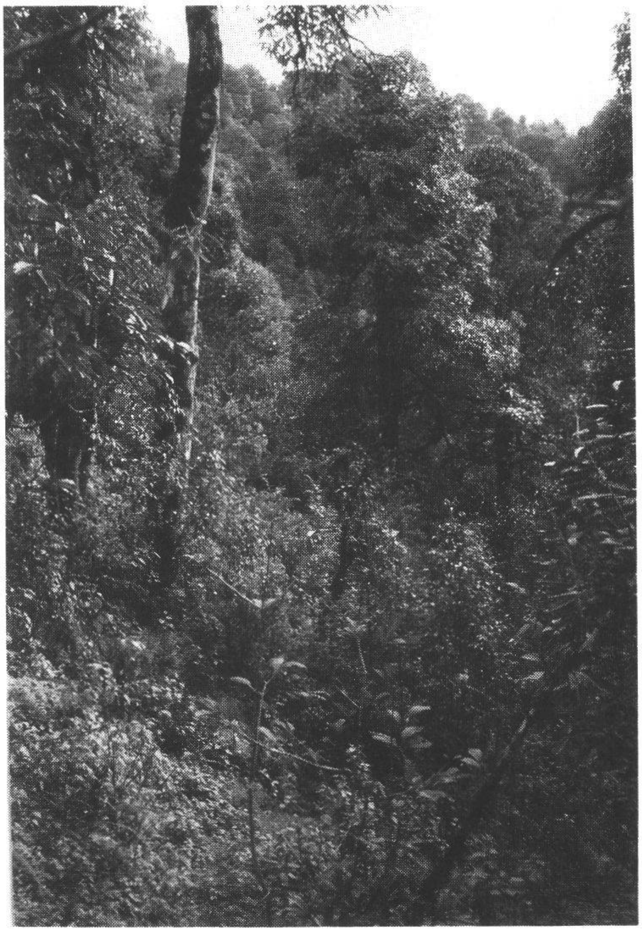


Fig. 4.25. Stable area s12. Hygrophilous forest with Daphniphyllum himalayense. 12.10.1984
Abb. 4.25. Intaktes Gebiet s12. Hygrophiler Wald mit Daphniphyllum himalayense. 12.10.1984

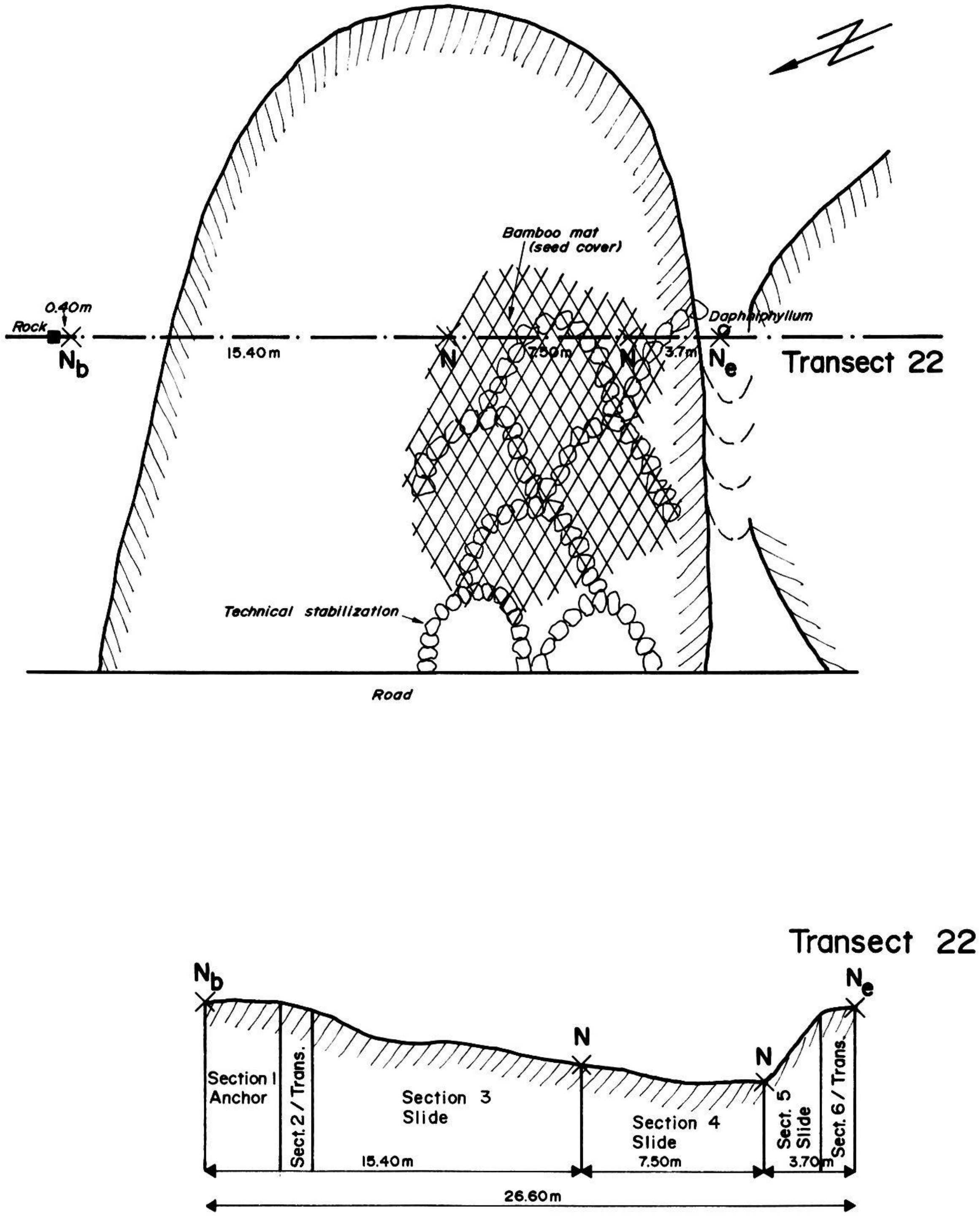


Fig. 4.26. Study plot 15 (not to scale) (for legend see Fig. 4.10)
Abb. 4.26. Untersuchungsfläche 15 (nicht massstäblich) (Legende siehe Abb. 4.10)

Fig. 4.27. Study plot 18, transect 25. Anchor in pasture land.
17.10.1983
Abb. 4.27. Untersuchungsfläche 18, Transekt 25. Anker in Weideland.
17.10.1983

Fig. 4.28. Study plot 21, transect 29. Anchor in pasture land.
17.10.1983
Abb. 4.28. Untersuchungsfläche 21, Transekt 29. Anker in Weideland.
17.10.1983

with the surrounding area on Figures 3.2 and 3.3. The shrubland areas, though grazed on regularly by cattle and goats, are usually well covered by plants. But an interpretation of the vegetation table alone can be deceptive. The herb layer - even if rich in species - is, with the exception of Eupatorium and a few other unpalatable plants, very short; particularly the nutritious Gramineae and herbs like Arundinella, Arthraxon, Sacciolepis, Sporobolus, Taraxacum, Smithia etc. are diminutive.

Fig. 4.29. View of study plot 22, transect 30, 31. Anchor in mesohygrophilous forest with Quercus semecarpifolia (stable area sl3). June 1985

Abb. 4.29. Blick auf Untersuchungsfläche 22, Transekt 30, 31. Anker in mesohygrophilem Wald mit Quercus semecarpifolia (intaktes Gebiet sl3). Juni 1985

The stable areas s1 and s2 (Figs. 4.7-4.9) represent xerophilous Pinus roxburghii-forests. No. s1 had been protected from burning and grazing for eight years till 1980; after burning in 1980, protection started again in 1982, which is to last till 1989. The shrub and especially the herb layer of No. s1 are much richer in species than the layers of No. s2, where burning and grazing is a regular occurrence.

The areas s4, s5 and s8 (Figs. 4.13, 4.19, 4.20) lie in mesohygrophilous forest. In No. s8, the very small remains of a forest, Schima wallichii is the dominant tree species, besides which only a few Lyonia ovalifolia occur. The shrub layer is dominated by Dicranopteris linearis and Phyllanthus parvifolius. The areas s4 and s5 are samples of a mixed forest with Schima wallichii, Rhododendron arboreum and Castanopsis. No. s4 in particular, which, unlike No. s5, lies in the center of the quite well preserved small forest, is rich in species in all the layers.

Nos. s12a-s12d (Fig. 4.25) are records from different plots of the same hygrophilous forest with Daphniphyllum himalayense dominating. Symplocos crataegoides and Alnus nepalensis are abundant too. Besides the well developed shrub layer with Viburnum erubescens, Daphne bholua, Sarcococca

Fig. 4.30. Study plot 22, transect 30. Anchor in heavily lopped Quercus semecarpifolia-forest. 8.10.1984

Abb. 4.30. Untersuchungsfläche 22, Transekt 30. Anker in stark geschneiteltem Quercus semecarpifolia-Wald. 8.10.1984 pruniformis etc., the herb layer is rich in species, with Strobilanthes sp., Ellisiophyllum pinnatum, Chambainia cuspidata and Athyrium sp. as main species. To protect the forest, IHDP installed a fence around an area of about 25 ha in 1981 (SINGY 1982).

Stable area sl3 (Figs. 4.29-4.31) is part of a mesohygrophilous forest with Quercus semecarpifolia as dominant tree. The area is much exploited: The oaks are heavily lopped and the whole slope is grazed on regularly. The shrub layer is undeveloped and the herb layer is rather poor in species with Strobilanthes sp., Anaphalis triplinervis, Anaphalis contorta and Arthraxon lancifolius dominating.

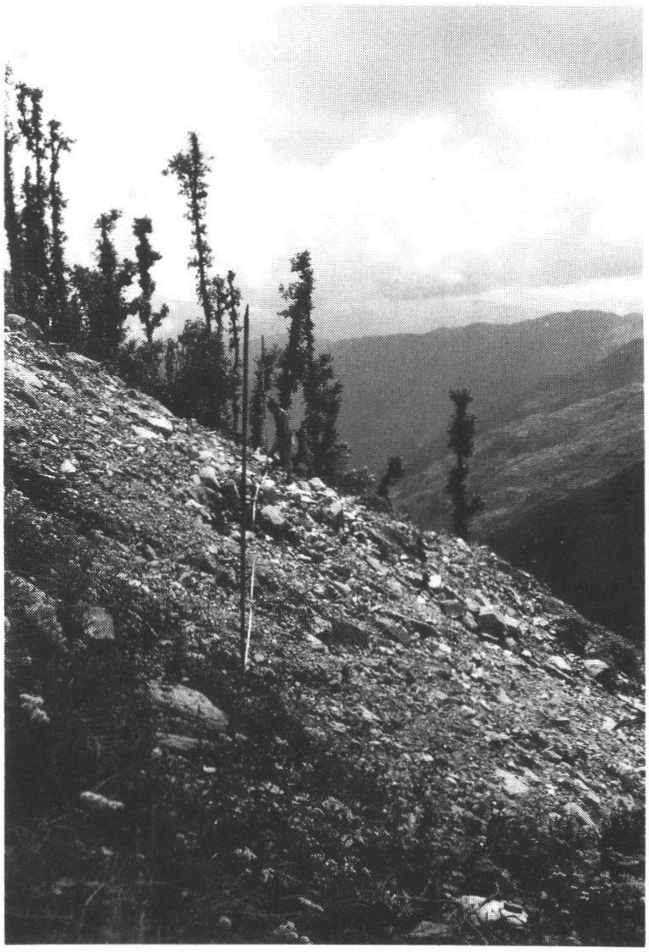
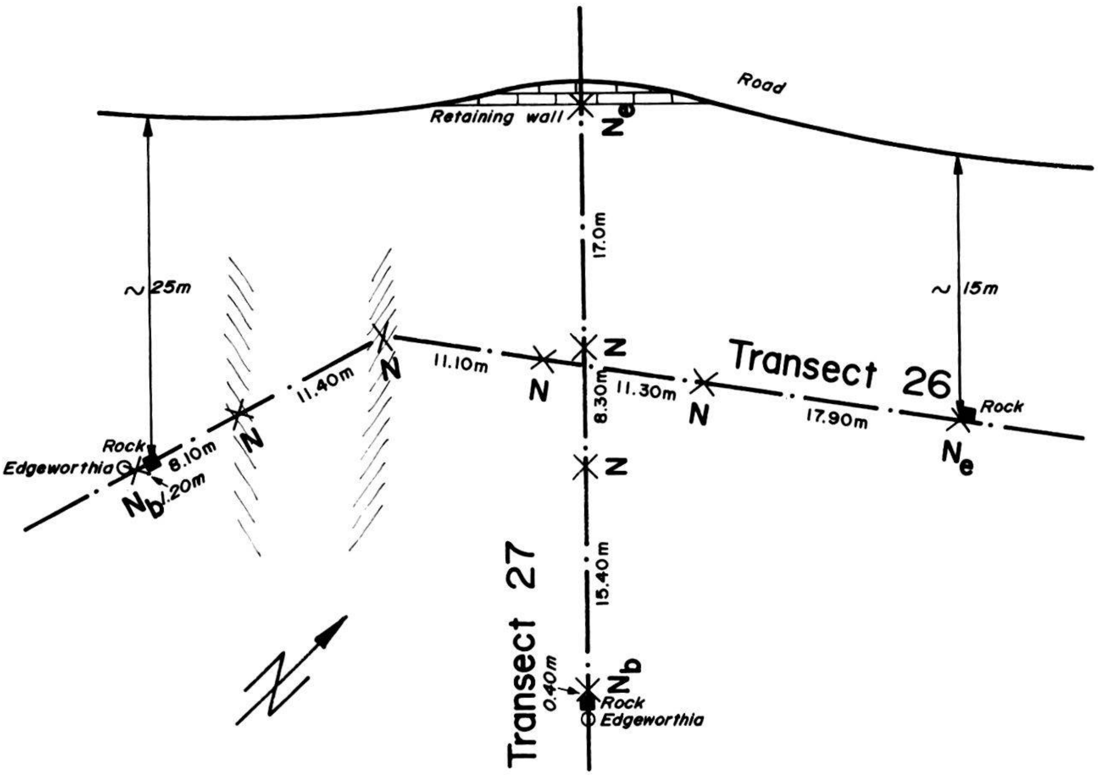
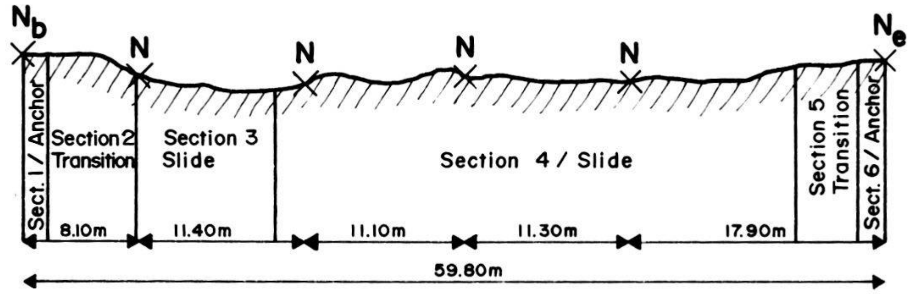
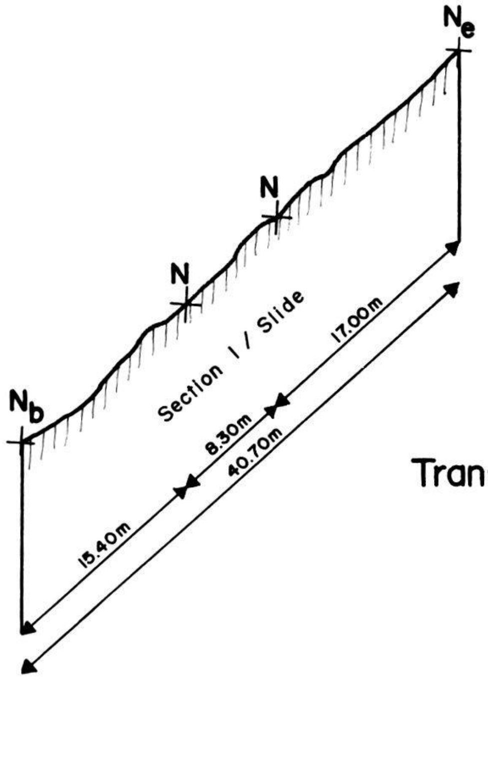


Fig. 4.31. Study plot 22, transect 30. Anchor in heavily lopped Quercus semecarpifolia-forest. 8.10.1984

Abb. 4.31. Untersuchungsfläche 22, Transekt 30. Anker in stark geschneiteltem Quercus semecarpifolia-Wald. 8.10.1984


Road
Retaining wall
Ne
17.0m
~25m
~15m
11.40m
11.10m
8.30m
11.30m
17.90m
Transect 26
Rock
Rock
Edgeworthia
8.10m
.20m
Nb
N
Ne
15.40m
Transect 27
0.40m
Nb
Rock
Edgeworthia


Transect 26
Nb
N
Ne
Sect. 1 / Anchor
Section 2 Transition
Section 3 Slide
Section 4 / Slide
Section 5 Transition
Sect. 6 / Anchor
8.10m
11.40m
11.10m
11.30m
17.90m
59.80m


Ne
N
N
Nb
Section 1 / Slide
17.00m
8.30m
40.70m
15.40m

Transect 27

4.1.3. Plant communities of unstable slopes

Group 1. Low altitude.

The dominance of Eupatorium adenophorum, Pogonatherum sp., Gonostegia hirta, Phyllanthus parvifolius, Brachiaria villosa and Pogonatum seminudum is conspicous. Besides this the following communities can be found (Table 4.1., in the pocket of the cover):

- General slide community on rather unstable slopes, with northern aspect: This community is dominated by mosses, especially Pogonatum junghuhnianum, and Vandellia sp.; Desmodium concinuum is fairly abundant too. Alnus nepalensis, though cultivated (study plot 1, transects 1-3), shows good growth.
- General slide community on rather stable slopes, with northern and southern aspect: Here Schizachyrium brevifolium, Osbeckia nepalensis, Murdannia nudiflorum, Fimbristylis dichotoma are abundant besides a variety of other species.
- Older slide community, northern aspect, rather wet. In addition to the previous community Drymaria diandra, Eriocaulon nepalensis and Cyperus aristatus appear, indicating a wet ground.

Group 2. Lower middle altitude with a generally southern aspect.

Here too, Eupatorium adenophorum and Pogonatherum sp. are dominant, supplemented with Arundinella nepalensis, Sporobolus piliferus, Brachiaria villosa, Sacciolepis indica, Imperata cylindrica, Pogonatum junghuhnianum and P. seminudum. Alnus nepalensis, often cultivated, grows without restraint. Among this basic species group the following communities are found (Table 4.2, in the pocket of the cover):

- General slide community with Arthraxon lancifolius, Vandellia nummularifolia, Drymaria diandra, Hypericum japonicum etc.
- Dispersed slide community with Eragrostis atrovirens and Polygonum nepalensis.
- The community on plot 27 (transects 36, 37, Fig. 4.15), an old, sandy and wet landslide with only 50% slope, shows as variant of the region

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Fig. 4.32 (p. 58). Study plot 19 (not to scale) (for legend see Fig. 4.10)
Abb. 4.32 (S. 58). Untersuchungsfläche 19 (nicht massstäblich) (Legende siehe Abb. 4.10)

Chrysopogon gryllus, Saccharum spontaneum, Calamagrostis pseudophragmites combined with the general slide community.

Group 3. Higher middle altitude with a generally northern aspect.

The older slides are generally covered with Eupatorium adenophorum, Microstegium nudum, Chambainia cuspidata, Hypericum uralum, Alnus nepalensis (only partly cultivated), Pogonatum seminudum. Besides these plants two main groups can be distinguished (Table 4.3, in the pocket of the cover):

- General slide community on younger or dry slopes with poor soil, or pH-value higher than 6.7: Pogonatherum sp., Anaphalis contorta, Eulalia mollis, Polygala triphylla dominate.
- General slide community on older, more developed or wet slopes with richer soil and low pH: Gaultheria fragrantissima, Hydrocotyle sp., Impatiens sp., Microstegium ciliatum, Drymaria diandra, Pogonatum junghuhnianum etc. are abundant.

Group 4. High altitude.

The dominant species in the slide sections at this altitude are Pogonatum sp., Dicranella sp., Anaphalis contorta, Impatiens sp., Hemiphragma heterophyllum, Arthraxon lancifolius, Carex atrata, Arundinella hookeri etc. Within this basic group three specific communities can be seen (Table 4.4, in the pocket of the cover):

- Slide community on poorer soil with Gaultheria fragrantissima, Lyonia ovalifolia, Digitaria ascendens, Rubus ellipticus.
- Slide community on wet, richer soil: It combines the previous community with Hydrocotyle spp., Calaminthe umbrosum, Stellaria patens, Mazus japonicus, Plantago major.
- Slide community on wet soil with Chambainia cuspidata, Gonostegia hirta, Drymaria diandra, Selaginella sp., Cyanotis sp., Swertia sp., etc.

4.1.4. Development and change

Generally it was found that the plant cover on the slide sections became denser during the three years of the study. The increasing plant frequencies in Table 4.6 (in the pocket of the cover) of the three postmonsoon records (1983-1985) of group 1 illustrate this fact. With regard to the floral composition, a certain development of the slide sections towards the transitions, and of the transitions towards the anchors can be observed. Table 4.7 (in the pocket of the cover) gives an overview of the most represented species in the three sections of the four groups of the study. It is not possible to draw a strict line between the groups and the sections since environmental factors such as altitude, aspect, soil, etc. interfere too much.

The first plants to appear on a young slide are usually mosses, especially Pogonatherum sp. At lower altitudes they are followed by Gramineae like Pogonatherum sp. and Schizachyrium brevifolium, at middle altitudes Sporobolus piliferus and Brachiaria villosa predominate and at higher altitudes Arthraxon lancifolius is abundant. Alnus nepalensis and Eupatorium are usually among the first settlers; in the studied plots this fact was often supported by planting or sowing Alnus, and in some places Eupatorium. At low altitudes Gonostegia hirta and often Osbeckia nepalensis appear soon too, at middle altitudes Drymaria diandra, Chambainia cuspidata and Polygonum uncinatum and at high altitudes Anaphalis contorta.

If undisturbed, the plant cover on a slide gets denser and richer in species quite quickly, especially in the favourable climates of lower and middle altitudes. More ambitious Gramineae appear like Hackeochloa granularis at low altitude (but Pogonatherum is still dominant), Imperata cylindrica and Calamagrostis pseudophragmites on dry slopes at middle altitude and Microstegium nudum, Eulalia mollis and Pogonatherum sp. on wetter slopes. The number of shrubs and perennials is increasing with Phyllanthus parvifolius, Hypericum cordifolium and abundant Osbeckia nepalensis at low altitude, Berberis aristata and B. asiatica, Eupatorium adenophorum, Anaphalis contorta and Gonostegia hirta at southfacing middle altitude, Gaultheria fragrantissima, Phyllanthus parvifolius, Artemisia sp., Ellisiophyllum pinnatum and Selaginella sp. at more northfacing middle altitude. At high altitude, besides the increasing number of species also typical for relatively undisturbed grassland like Agrostis pilosula, Arundinella hookeri, Eragrostis papposa, Tripogon filiformis, Carex atrata, Bulbostylis capillaris and Potentilla fulgens, also Rubus nepalensis, Elsholtzia pilosa and Hemiphragma heterophyllum appear. With the exception of Alnus and - only on dryer slopes of the low altitude - Pinus roxburghii, the trees settle hesitantly. Schima wallichii and more seldom Lyonia ovalifolia can be found at lower and middle altitudes, Rhododendron arboreum - slow growing - at middle and high altitudes.

The appearance of trees and other perennials leads from the transition to the anchor sections. Obviously, quite a number of species are found in either of them, but the anchors are much richer in species. Some plants seem to prefer a stabilized situation and occur almost only in anchors or in sections which have somewhat consolidated. In lower altitudes this is true for Engelhardtia spicata, Castanopsis indica, Indigofera dosna, Dicranopteris linearis and to some extent Imperata cylindrica, Cheilanthes farinosa and Pteridium aquilinum. In middle altitudes with southern aspect Eurya spp., Lyonia ovalifolia, Gaultheria fragrantissima, Arundinella nepalensis, Carex cruciata and Dicranopteris linearis and in middle altitudes with northern aspect Eurya spp., Myrsine semiserrata, Neillia thyrsiflora, Carex spp., Ellisiophyllum pinnatum, Lycopodium clavatum, Ptychanthus sp. and to some extent Dicranopteris linearis, Pteridium aquilinum, Selaginella sp. and Ectropothecinus sp. all seem to prefer a more stable plot. At high altitude species like Quercus semecarpifolia, Symplocos spp., Microstegium spp., Oryzopsis lateralis, Carex cruciata, Roscoea purpurea, Anemone rivularis, Strobilanthes sp. and Valeriana hardwickii are seldom found on unstable sites.

The seasonal changes of the plant cover in the slide and transition sections is conspicuous. While young shoots on trees like Alnus nepalensis, Daphniphyllum himalayense, Lyonia ovalifolia and Rhododendron arboreum and on perennials like Anaphalis contorta and Eupatorium adenophorum sprout strongly already in March and April, the ground of the studied slides stayed bare and dry - if not covered by Alnus or Eupatorium - except perhaps for a few perennial Gramineae like Imperata cylindrica, Eragrostis papposa, Poa sp., or some Carex or Polygonum spp. Tables 4.8 and 4.9 (in the pocket of the cover) represent the plant cover from a selection of the best covered plots in April 1985. With the start of the premonsoon rains in April/May and at the beginning of the monsoon in mid-June, the seedlings start growing abundantly and the more stable or older slides are soon quite well covered. Table 4.10 (in the pocket of the cover) with the plants recorded in June/July 1985 on the plots of group 1 illustrate this. In the early monsoon time it is difficult to identify the numerous young Gramineae, but by August, September and October most of the Gramineae are flowering, the herbs and shrubs are in full sap. With the decreasing precipitation after the monsoon in October

and November the plants get drier or disappear again.
The following is an attempt to interpret the changes of the vegetation cover over the three years of the study, mainly relying on the three September/October surveys from 1983-1985. As mentioned earlier, for each of the groups an ordination (scatter diagram) as well as a cluster analysis (dendrogram) was computed and a plant frequency table was printed. To give an impression of the interplay of these different possibilities of investigating a development trend, Table 4.6 (plant frequency; in the pocket of the cover), Fig. 4.33 (ordination) and Fig. 4.34 (cluster analysis) of group 1 are displayed. The evaluation has been done in the same way for group 2-4. But here, for the sake of lucidity, only the ordination graphs are shown. The additional data have been deposited in the archivs of the Geobotanical Institute.

Group 1. Low altitude.

Fig. 4.33 shows the scatter diagram of the relevés and species of the three postmonsoon records of group 1. The additional study of the cluster analysis (Fig. 4.34) and the frequency table (Table 4.6, in the pocket of the cover) tend to confirm the following interpretations:
The five anchor sections of plots No. 1 (transects 1-3) and No. 2 (transects 4-6) lie close to the second axis. The related species are Engelhardtia spicata, Lyonia ovalifolia, Phyllanthus parvifolius, Oplismenus compositus and Dicranopteris linearis.
Slide No. 1 occurred during monsoon 1981. Most of its slide sections lie in the fourth quadrant, connected with Alnus nepalensis, which was planted in this slide by LJRP for stabilization. These sections show, if not a straight line, a clear movement towards the anchors. Slide No. 2 dates back to monsoon 1977. Its slide sections lie and point generally more towards the anchors than those of No. 1. Frequency table 4.6 shows clearly that they have a denser plant cover, richer in species, than No. 1. This may indicate a more advanced development.
The transition section of transect No. 2 points towards the anchors of plots 1 and 2.
The anchors of plot No. 3 (transect No. 7) lie along the first axis between the second and third quadrant with Pinus roxburghii and Indigofera dosna as main species. The transitions point clearly towards these anchors, the slide sections towards the transitions. According to the frequency table, the vegetation here has obviously become denser with Pogo-

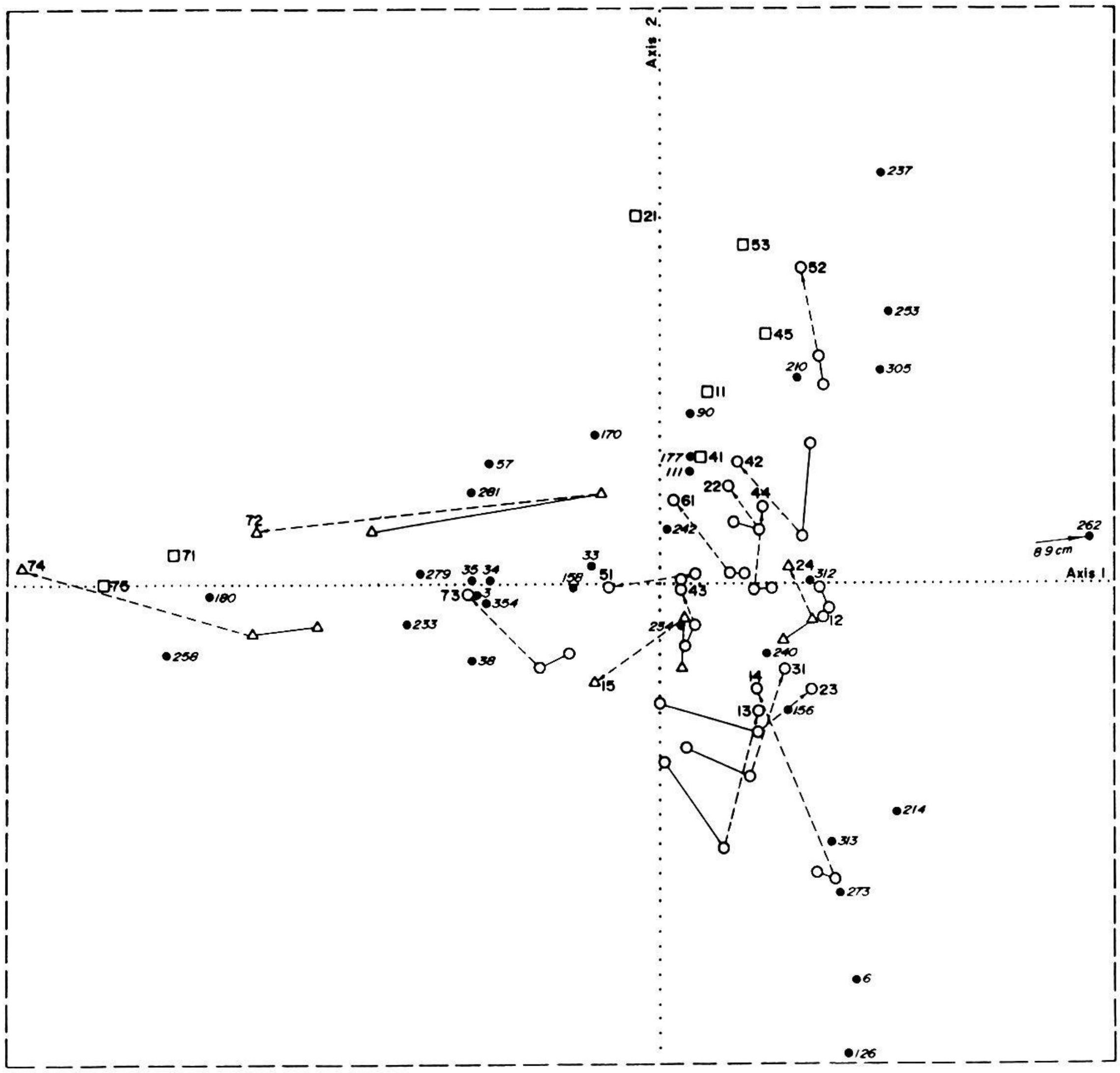


Fig. 4.33. Ordination of postmonsoon records (1983, 1984, 1985).
Group 1: Development and change.

Abb. 4.33. Ordination der Aufnahmen nach dem Monsun (1983, 1984, 1985).
Gruppe 1: Entwicklung und Veränderungen.

Anchor □ 335

Transition △——△- - -→△ 302 Transect No.

Slide ○——○- - -→○ 31 Section in transect

(year) (1983) (1984) (1985)

Species ●288 (for No. and species name see tables 4.1-4.4, 4.6. Species unspecifically concentrated in the centre are not shown)

●← 8.9 cm distance from center

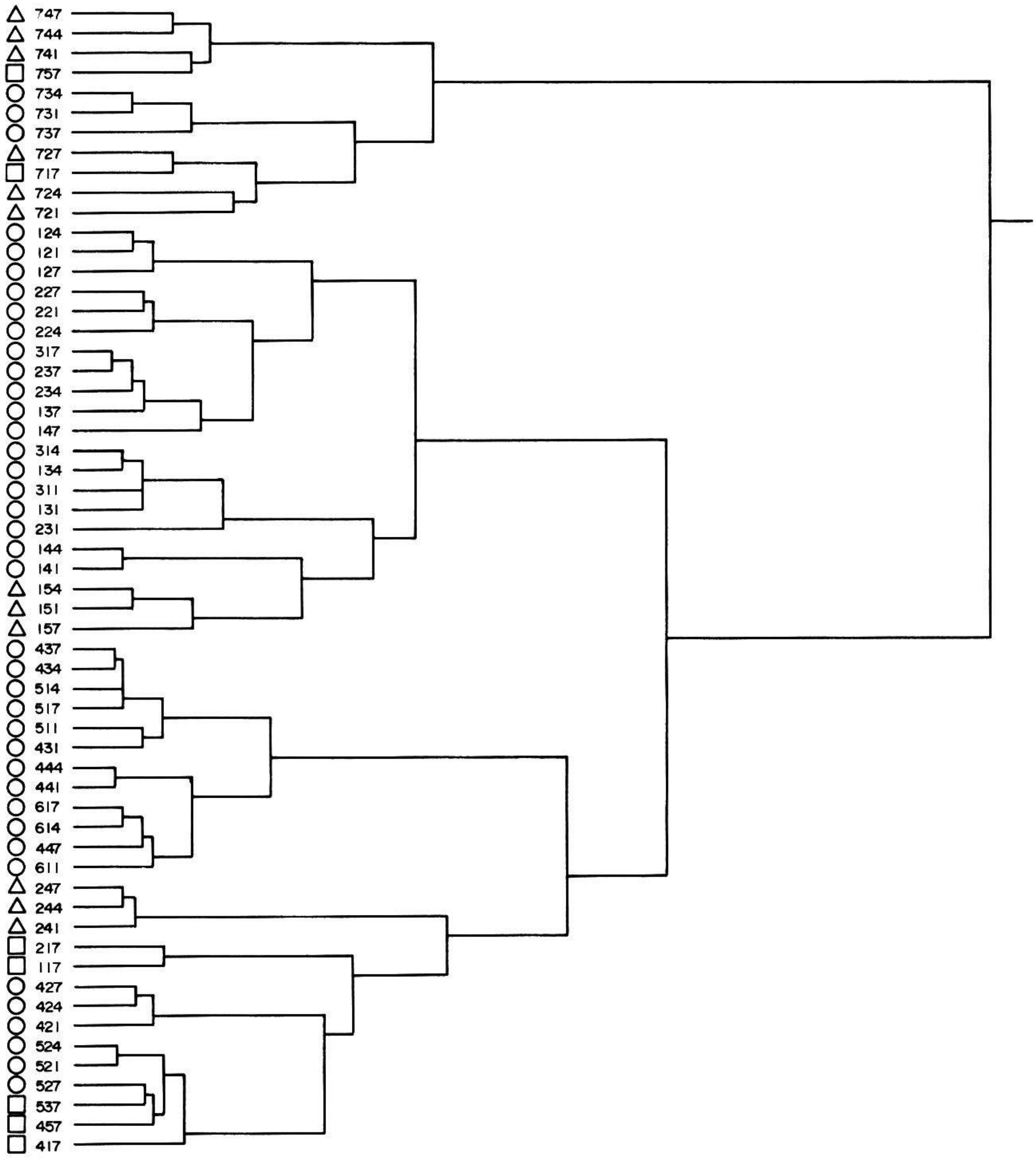
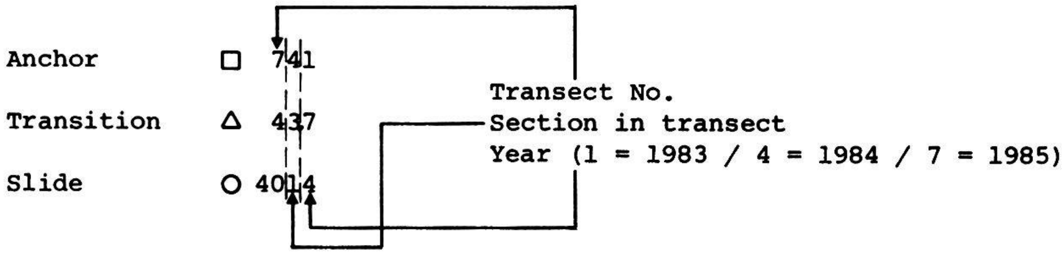


Fig. 4.34. Cluster analysis of postmonsson records (1983, 1984, 1985).
Group 1: development and change.
Abb. 4.34. Dendrogramm der Aufnahmen nach dem Monsun (1983, 1984, 1985).
Gruppe 1: Entwicklung und Veränderungen.



natherum sp., Sacciolepis indica, Brachiaria villosa, Hypericum cordifolium, Biophytum sensitivum, Borreria stricta, Phyllanthus niruri etc.; the regeneration of Pinus roxburghii is striking.

Group 2. Middle altitude with a generally southern aspect.
This group covers 15 plots and therefore yields a wide variety of development trends shown in the scatter diagram (Fig. 4.35).

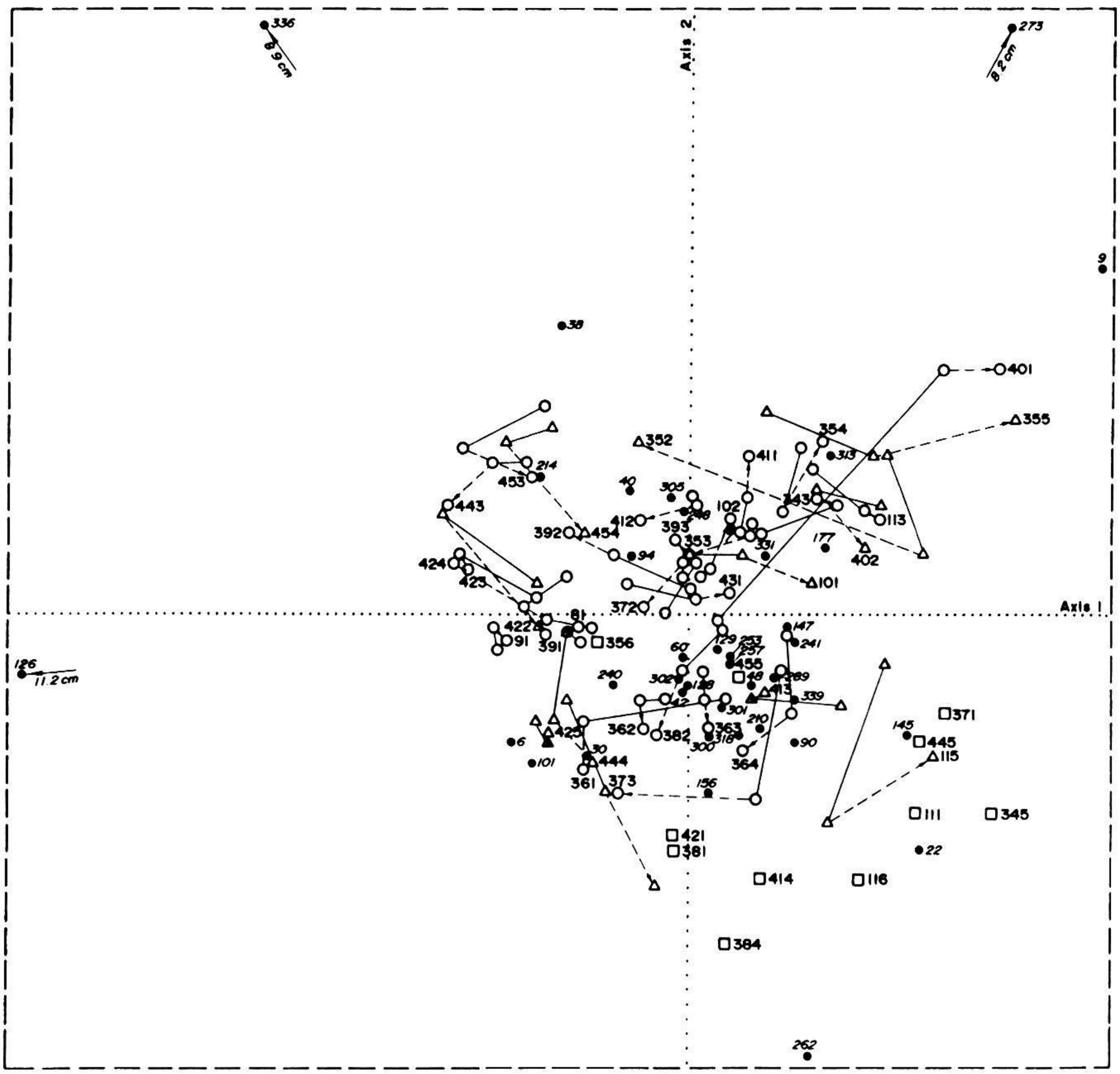


Fig. 4.35. Ordination of postmonsoon records (1983, 1984, 1985)
Group 2: Development and change (for legend see Fig. 4.33)
Abb. 4.35. Ordination der Aufnahmen nach dem Monsun (1983, 1984, 1985).
Gruppe 2: Entwicklung und Veränderungen (Legende siehe Abb. 4.33)

The anchors lie mainly in the fourth quadrant with Gaultheria fragrantissima, Lyonia ovalifolia, Gonostegia hirta, Arundinella nepalensis and Dicranopteris linearis as related species. As an exception, anchor 26 (transect 35) lies in the third quadrant, with Alnus nepalensis, Berberis aristata, Osbeckia nepalensis and Drymaria diandra; anchor 28 and 32 (transects 38 and 42) lie along the second axis between the third and fourth quadrant.

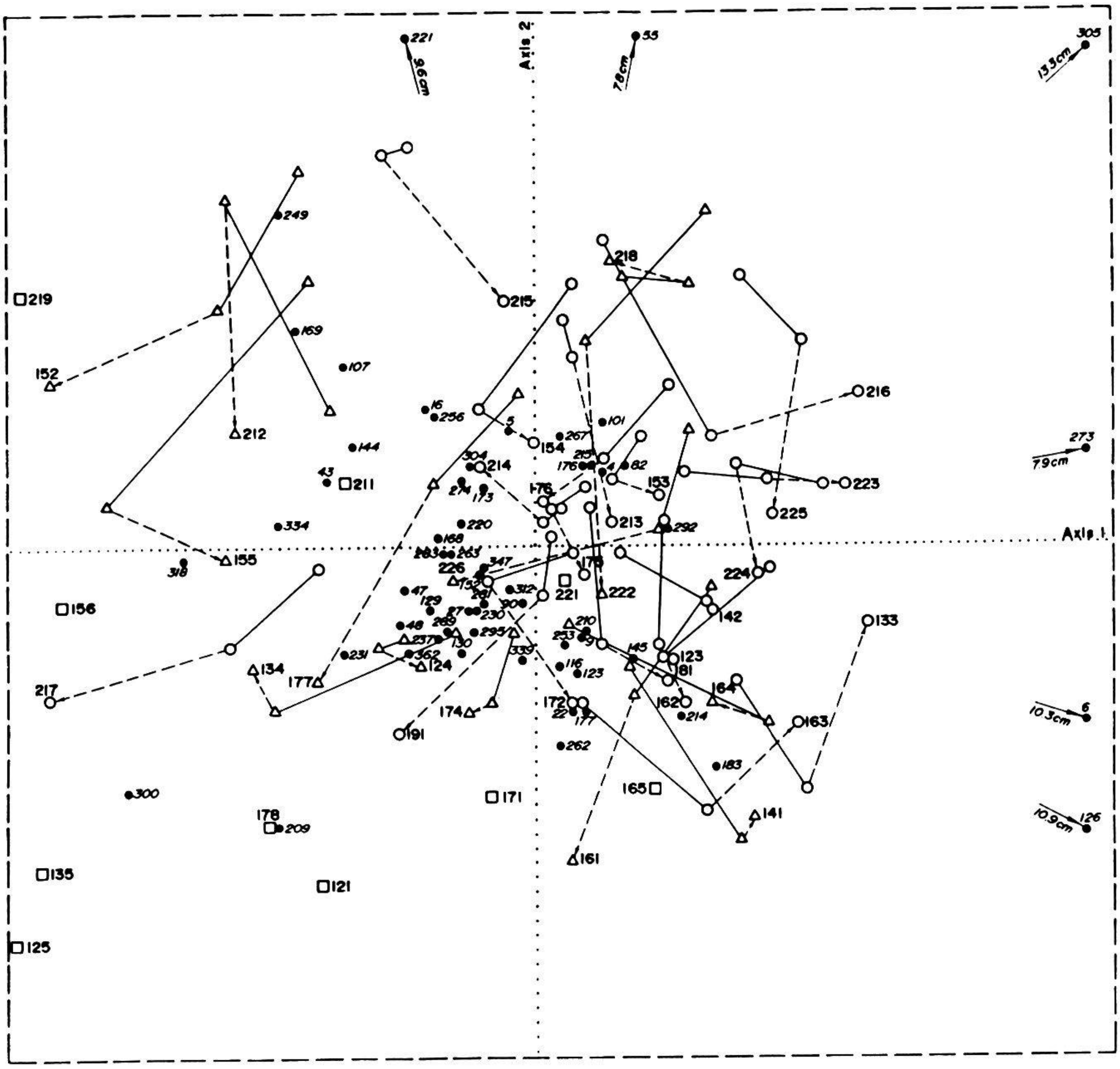


Fig. 4.36. Ordination of postmonsoon records (1983, 1984, 1985).
Group 3: Development and change (for legend see Fig. 4.33)

Abb. 4.36. Ordination der Aufnehmen nach dem Monsun (1983, 1984, 1985).
Gruppe 3: Entwicklung und Veränderungen (Legende siehe Abb. 4.33)

The other sections are very scattered over the diagram, but some trends can be stated:

The transitions - lying in all four quadrants - remain somewhat peripheral. Those in the third quadrant are grouped around Alnus nepalensis, Berberis aristata, Osbeckia nepalensis and Drymaria diandra. The transitions of Nos. 28 and 34 (transects 38 and 44) indicate a trend towards the anchors 28 and 32. No. 7 moves definitely towards anchors 7, 31 and 34 (transects 11, 41 and 44) and transitions No. 31 towards anchor 35 (transects 41 and 45). Transitions 29 and 35 (transects 39 and 45) are directed towards anchor 26 (transect 35).

The slope sections also lie in all four quadrants. They point in all directions, in general tending towards the peripheral transitions.

Group 3. Middle altitude with a generally northern aspect.

The scatter diagram of the three postmonsoon records of group 3 is given in Fig. 4.36.

The anchors lie mainly in the third quadrant with Eurya spp., Neillia thyrsiflora, Carex spp., Lycopodium clavatum, Selaginella sp. and Ptychanthus striatus as the main related species. Exceptions are plots No. 14 (transect 21) with the anchors in the second quadrant, and No. 20 (transect 28) plus the anchor of No. 11 (transect 16) in the fourth quadrant with Alnus nepalensis.

To some extent most of the transitions tend towards the anchor group. The trend of the slide sections is less clear. However there is an accumulation of slide sections in the first quadrant with a general tendency towards the different transitions.

Group 4. High altitude.

The scatter diagram (Fig. 4.37) of the postmonsoon records of group 4 shows the following situation:

The anchors lie in the second quadrant with Quercus semecarpifolia, Fragaria sp., Strobilanthes atropurpureus and Oryzopsis lateralis as main related species. There are a few exceptions: the anchor of plot No. 21 (transect 29), a well diversified grassland with Elsholtzia pilosula, Hemiphragma heterophyllum, Potentilla fulgens, Agrostis pilosula, Arundinella hookeri and Tripogon filiformis, lies in the fourth quadrant; anchor No. 24 (transect 33), a badly overexploited forest on wet ground, lies in the third quadrant with Chambainia cuspidata, Eupatorium adeno-

phorum, Galium sp. and Selaginella sp. as related species; the second anchor of No. 17 (transect 24) lies on the first axis between the second and third quadrant; anchor 1 of transect 30 of plot No. 22 lies along the second axis between the third and fourth quadrant.
The transition sections of Nos. 18, 19 and 21 (transects 25-27 and 29) are situated around anchor 21, the grassland; transitions 16 and 24 (transects 23 and 33) lie near anchor 24. The transitions of No. 22 and 23 (transects 30-32) point towards Quercus semecarpifolia.

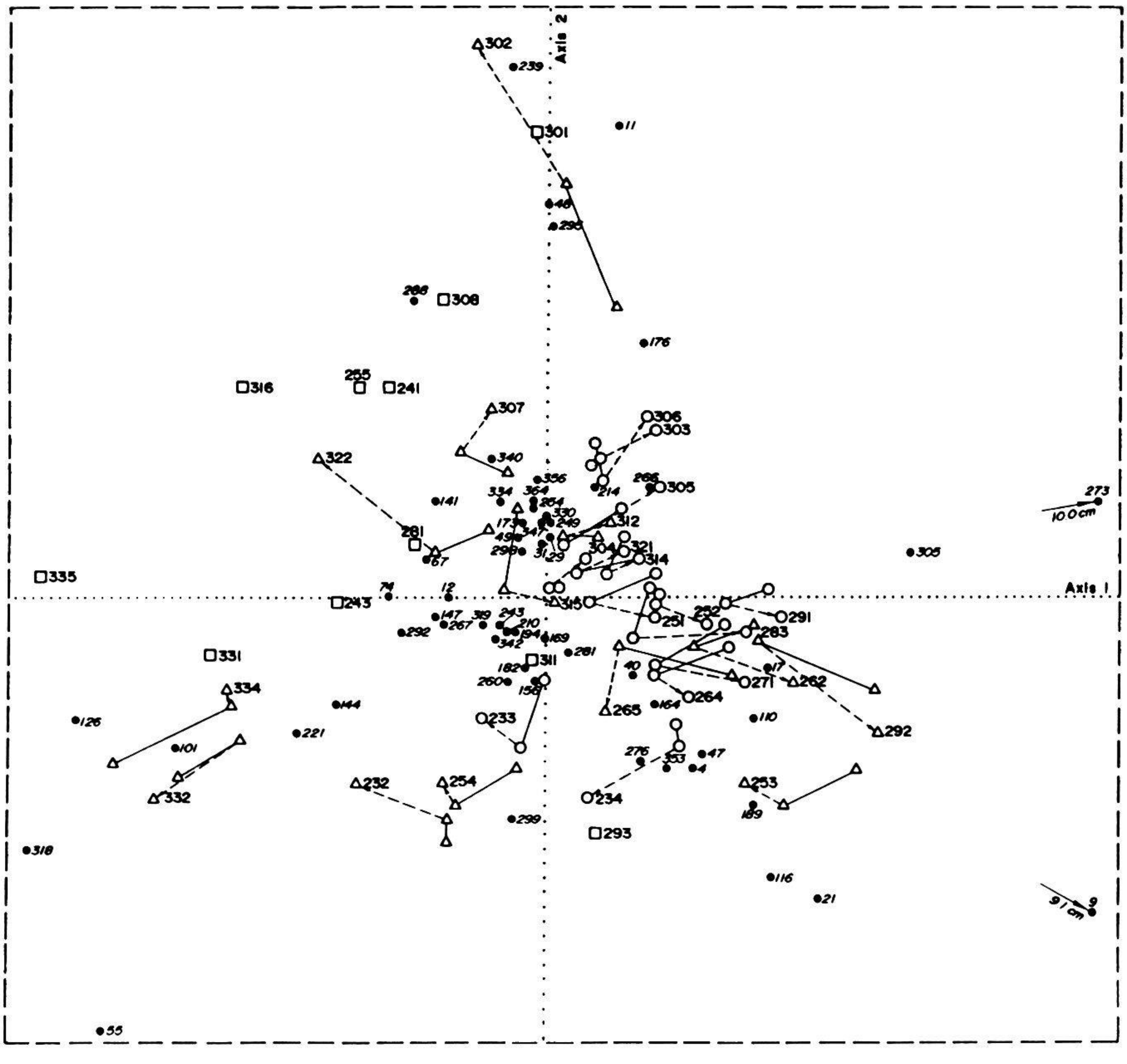


Fig. 4.37. Ordination of postmonsoon records (1983, 1984, 1985).
Group 4: Development and change (for legend see Fig. 4.33)
Abb. 4.37. Ordination der Aufnahmen nach dem Monsun (1983, 1984, 1985).
Gruppe 4: Entwicklung und Veränderungen (Legende siehe Abb. 4.33)

The slide sections 22 and 23 (transects 30-32) are grouped in the first quadrant; they do not show a strong tendency but only a slight upward-trend towards Impatiens racemosa and Anaphalis triplinervis. Slide sections 16 and 18-21 (transects 23 and 25-29) lie in the fourth quadrant; a development towards the transition sections 18-21 (transects 25-29) is visible. One slide section of No. 16 (transect 23) is definitely moving towards anchor 21 (transects 29), the other section of No. 16 lies in the third quadrant pointing towards anchor 24 (transect 33).

4.2. SOIL RESEARCH

The examination of the soil profile of each plot is supported by the detailed soil survey of the Lamosangu-Kharidhunga region by ESPINOSA (1974, 1975). A more rough and general analysis of the soil with chief importance on stability problems was done by LJRP (1977). Fig. 4.38 shows the soil associations of the Lamosangu-Kharidhunga area as evaluated by ESPINOSA; Tables 4.11 and 4.12 (in the pocket of the cover) by the same author give closer information on the soils found there. A summary of the field-data and the analytical data of the laboratory tests with an attempt to integrate these data in ESPINOSA's classification

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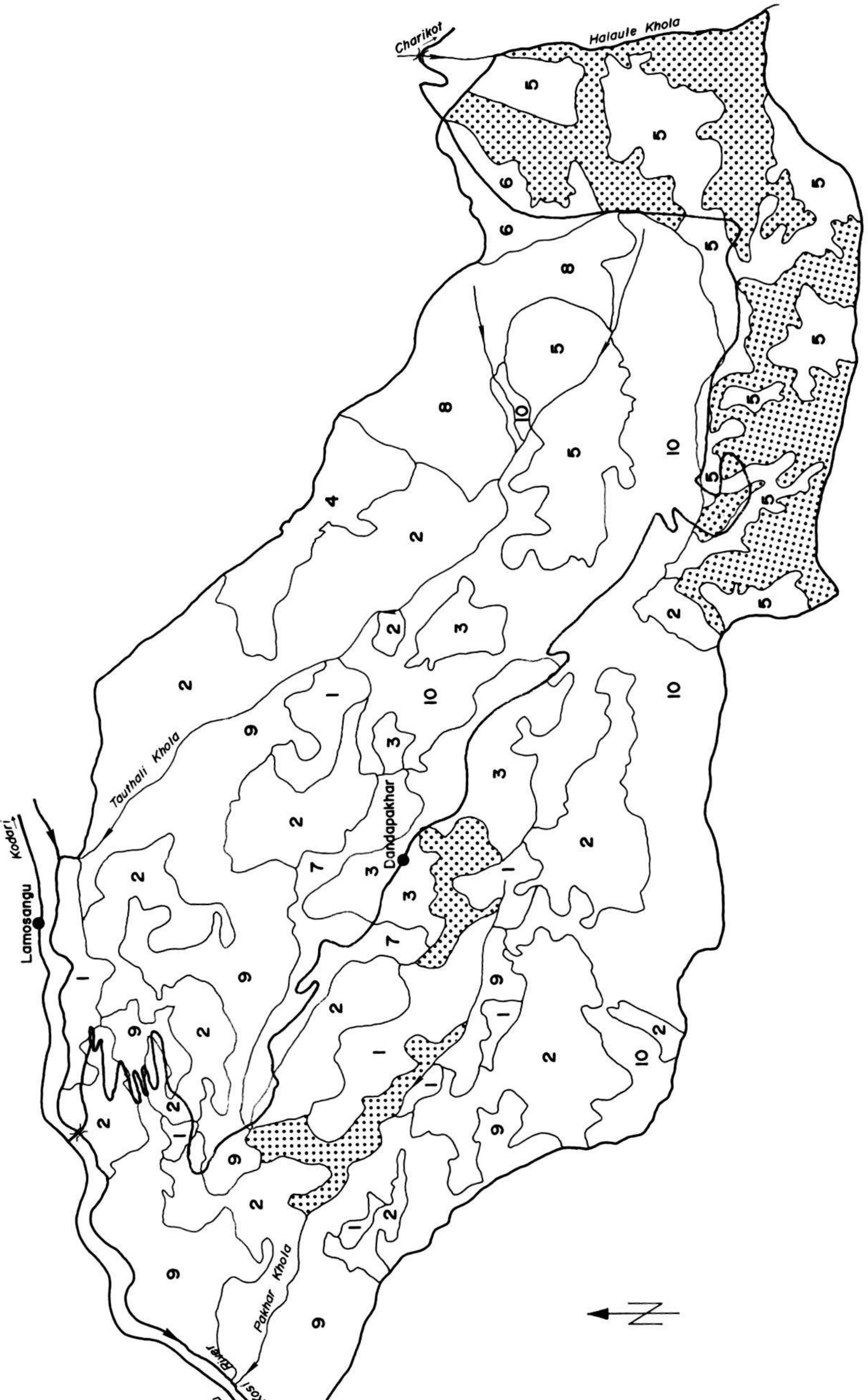
Fig. 4.38 (p. 71). Soil associations of Lamosangu-Kharidhunga area (after ESPINOSA 1975) (see also Table 4.13)
Abb. 4.38 (S. 71). Bodengruppen im Gebiet von Lamosangu-Kharidhunga (nach ESPINOSA 1975) (vgl. auch Tab. 4.13)

Soils of bench terraces:
1 Birta Besi - Birta Pakhar association
2 Dhuseni - Kathaike - Lapse association
3 Dhuseni - Golme Danda - Sukjani - Lapse association
4 Tauthali - Kathaike association
5 Sarai Danda - Sarangthali - Chitre - Burani association
6 Kharidhunga - Mane association
Soils of dissected hilly and mountainous lands:
7 Golme Danda - Deorali association
8 Sarai Danda association
9 Kaping and Guchchhe undifferentiated group
10 Sarai Danda, Golme Danda and Guchchhe undifferentiated group
Gullied land


Charikot
Halaule Khola
Tauthali Khola
Kodari
Lamosangu
Dandapakhar
Pakhar Khola
Sun Kosi River
Kathmandu

(see FAO-UNESCO 1974 and FAO 1977) is included in Table 4.13 (in the pocket of the cover) and in Table 4.14.

For the anchor sections the main soil groups are the Cambisols (dystric, humic and a few chromic) and the Acrisols (orthic and humic). Over the whole range of altitude there are obviously many transition stages not easily to interpret both in and between the two soil-groups, especially between orthic Acrisol and dystric Cambisol. The slide sections consist for the most part of dystric Regosols or - mainly on slopes cut because of road-construction - of Lithosols (as example see Figs. 4.21, 4.22). With the exception of slides 11 and 12 no measurable $CaCO_3$-content was found.

In general the pH-value is low. The discrepancy between the values measured on site and in the laboratory can be explained on the one hand by the use of different mediums to measure with and on the other hand by the circumstances in which the measuring took place: The augering and direct determination of the pH-value (Hellige) was undertaken in April when vegetation growth starts and the high CO_2-content then caused by plants and micro-organisms lowers the pH of a soil. The samples for the laboratory tests however were dug at the end of June after the start of the monsoon. They were then air-dried (which raises the pH slightly due to CO_2 escaping) and sent to Switzerland for further analysis; only there the pH(H_2O)-value was measured.

Table 4.14. Exchangeable cations and cation exchange capacity of selected soils

Tab. 4.14. Austauschbare Kationen und Kationen-Austauschkapazität in ausgewählten Böden

Plot No.	Exchangeable ions (m al/100 g soil)				CEC (mval/100 g soil)
	H^+	Ca^{2+}	Mg^{2+}	K^+	
s3	4.6	1.9	0.1	0.1	6.7
s4	8.5	1.9	0.8	0.3	11.5
s9	14.1	2.0	0.1	0.4	17.7
s11	7.5	0.9	0.1	0.1	8.5
s12a	14.4	7.7	1.6	0.4	24.1

4.3. EROSION RESEARCH

4.3.1. Meteorological data

A comparison of the climatograms of Dandapakhar, Bonch and Kirantichap for the years 1983-1985 with the corresponding climate diagrams (Fig. 4.39) demonstrates the following:

The monsoon rainfall started very late in 1983. Therefore only about 30% of the normal rainfall with much sunshine was registered for June. The

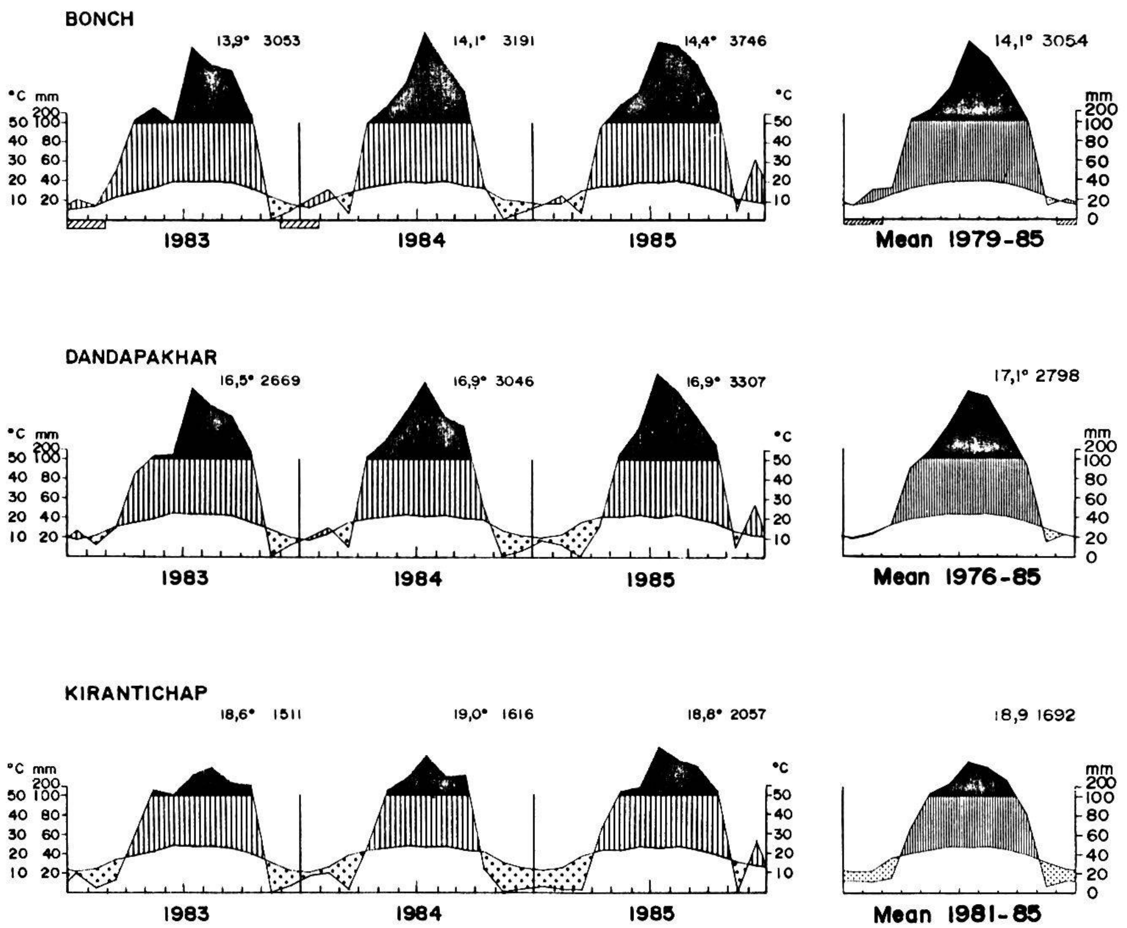


Fig. 4.39. Climatograms of study area, in comparison with climate diagrams (drawn by U. Schaffner, Emmenbrücke; IHDP-data) (for legend see Fig. 2.3)

Abb. 4.39. Klimatogramme aus dem Untersuchungsgebiet, im Vergleich mit den Klimadiagrammen (gezeichnet von U. Schaffner, Emmenbrücke; IHDP-data) (Legende siehe Abb. 2.3) rainy season lasted longer than usual. September had about 150% of the mean rainfall and October about 200%. The monsoon ended in the middle of October. The following dry season was fairly normal, with no rain in November and quite a dry March 1984. There was above average rainfall during May, June and July, and below average rainfall in August. The monsoon gradually ceased in September. There followed a very dry season from November to March 1985 with only about 50% of the normal rainfall. This dry period continued in Dandapakhar with only 30% of the mean rainfall in April. In June again less rain than usual was registered, but July was very rainy; Dandapakhar had the wettest July since 1976. A wet August and September and a very rainy October with more than 300% of the mean rainfall followed.

4.3.2. Station Dandapakhar

Monthly runoff, soil loss figures and rainfall erosivity of the two testplots for 1984 and 1985 are given in Figures 4.40 and 4.41. The total erosivity varies between 1471.5 in 1984 and 1621.2 (Joules·cm/ m^2·h·100) in 1985 (Table 4.15, in the pocket of the cover).
The recording raingauge was not working well for some days in July 1984 and for short periods from July to September 1985; on these occasions the hand-measured data taken from the simple raingauge - only measuring the amount of rain - were used for the calculation, with an estimation of the intensity.
Testplot 1, bare, experienced a total soil loss of 16.2 t per hectare in 1984. In 1985 the total soil loss was only 5.4 t per ha. Runoff figures are 5598 m^3 per ha or 18.7% of the rainfall in 1984 and 2454 m^3 per ha or 7.8% in 1985 (Table 4.15, in the pocket of the cover). The marked stones with an average diameter of 5 to 10 cm did not move down. The weekly weeding indicated a strong capacity for natural regrowth of plants. Table 4.16 gives an overview of the species which were removed most frequently. Compared with the surrounding unprotected area a certain stabilization took place thanks to the fence installed around the plot in April 1984.
Testplot 2, overgrown, experienced a total soil loss of 3.3 t per ha in 1984. In 1985 this was reduced to only 0.4 t per ha. Runoff figures are 5303 m^3 per ha or 17.7% of the rainfall in 1984 and only 277 m^3 per ha

or 0.8% in 1985 (Table 4.15, in the pocket of the cover). The plants grew well; there was a significant difference in the density of the plant cover between testplot 2 and the unprotected area outside the fence (Figs. 3.2, 3.3). Composition of plants in testplot 2 and their abundance are listed in Table 4.5 (stable area s3).

It should be taken into consideration that the soil of testplot 1 was loosened regularly by the weekly weeding. Even if done carefully, it might have increased the soil loss. But nevertheless the definitely lower soil loss and runoff on testplot 2 clearly shows the protecting power of plant cover on slopes.

Table 4.16. Testplots 1, bare: most frequent removed species
Tab. 4.16. Testflächen 1, kahl: die am häufigsten gejäteten Arten

Dandapakhar	Bonch
Eupatorium adenophorum	Berberis aristata
Hypericum cordifolium	Eupatorium adenophorum
Osbeckia nepalensis	Phyllanthus parvifolius
Phyllanthus parvifolius	Arthraxon lancifolius
Arundinella nepalensis	Arundinella nepalensis
Cynodon dactylon	Eragrostis papposa
Digitaria ascendens	Imperata cylindrica
Digitaria violascens	Pogonatherum crinitum
Eragrostis unioloides	Saccharum spontaneum
Schizachyrium brevifolium	Sacciolepis indica
Sporobolus piliferus	Schizachyrium brevifolium
Fimbristylis dichotoma	Sporobolus piliferus
Cyanotis vaga	Cyanotis vaga
Ageratum conycoides	Ageratum conycoides
Bidens pilosa	Anaphalis contorta
Drymaria diandra	Crotolaria albida
Euphorbia hirta	Euphorbia hirta
Gonostegia hirta	Gonostegia hirta
Micromeria biflora	Selaginella sp.
Polygonum spp.	Moss spp.
Selaginella sp.	
Pogonatum spp.	

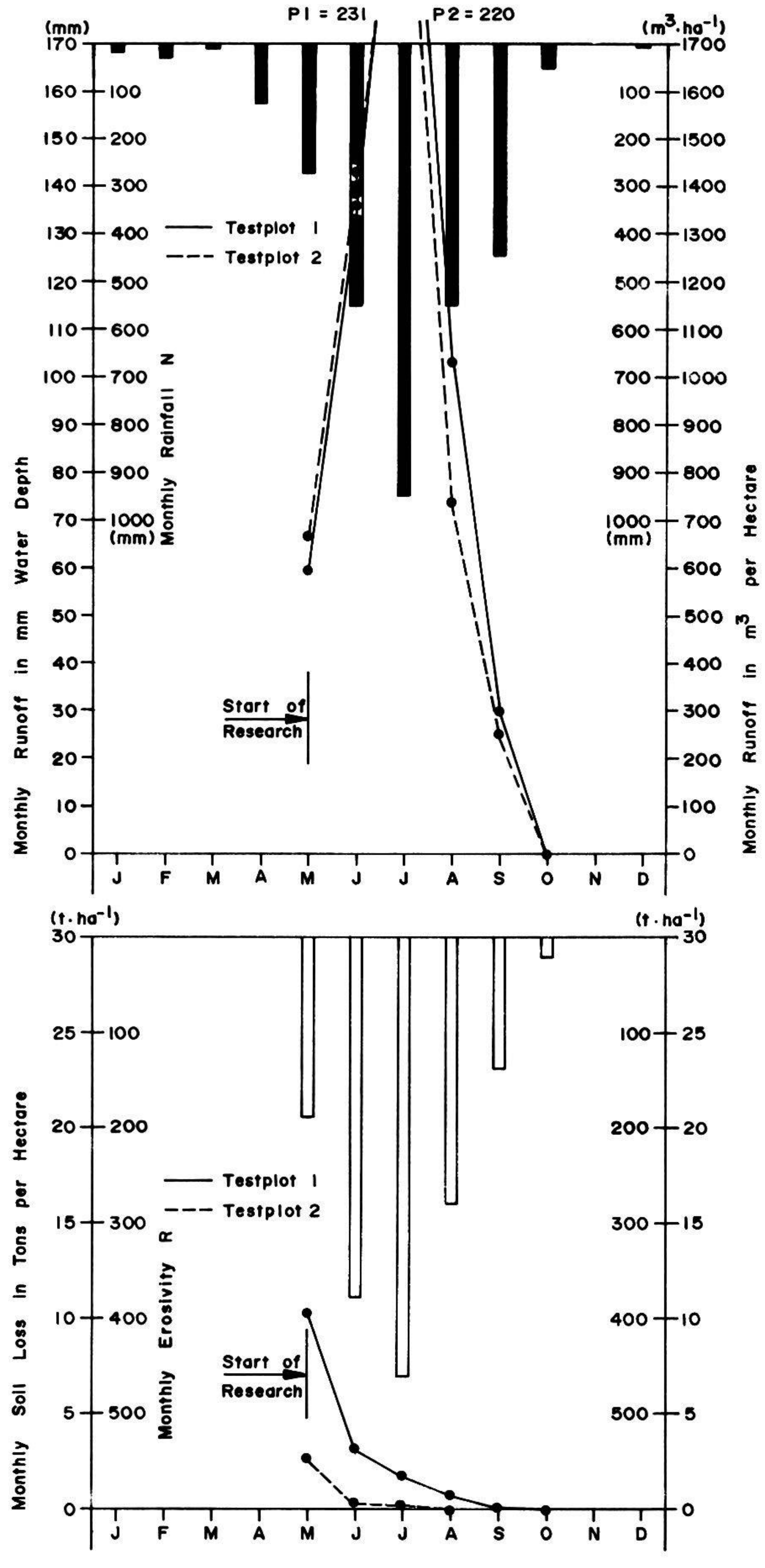


Fig. 4.40. Monthly rainfall, erosivity, runoff and soil loss: Testplots 1 and 2 at Dandapakhar, 1984

Abb. 4.40. Monatlicher Niederschlag, Erosivität, Abfluss und Boden-Abtrag: Testflächen 1 und 2 in Dandapakhar, 1984

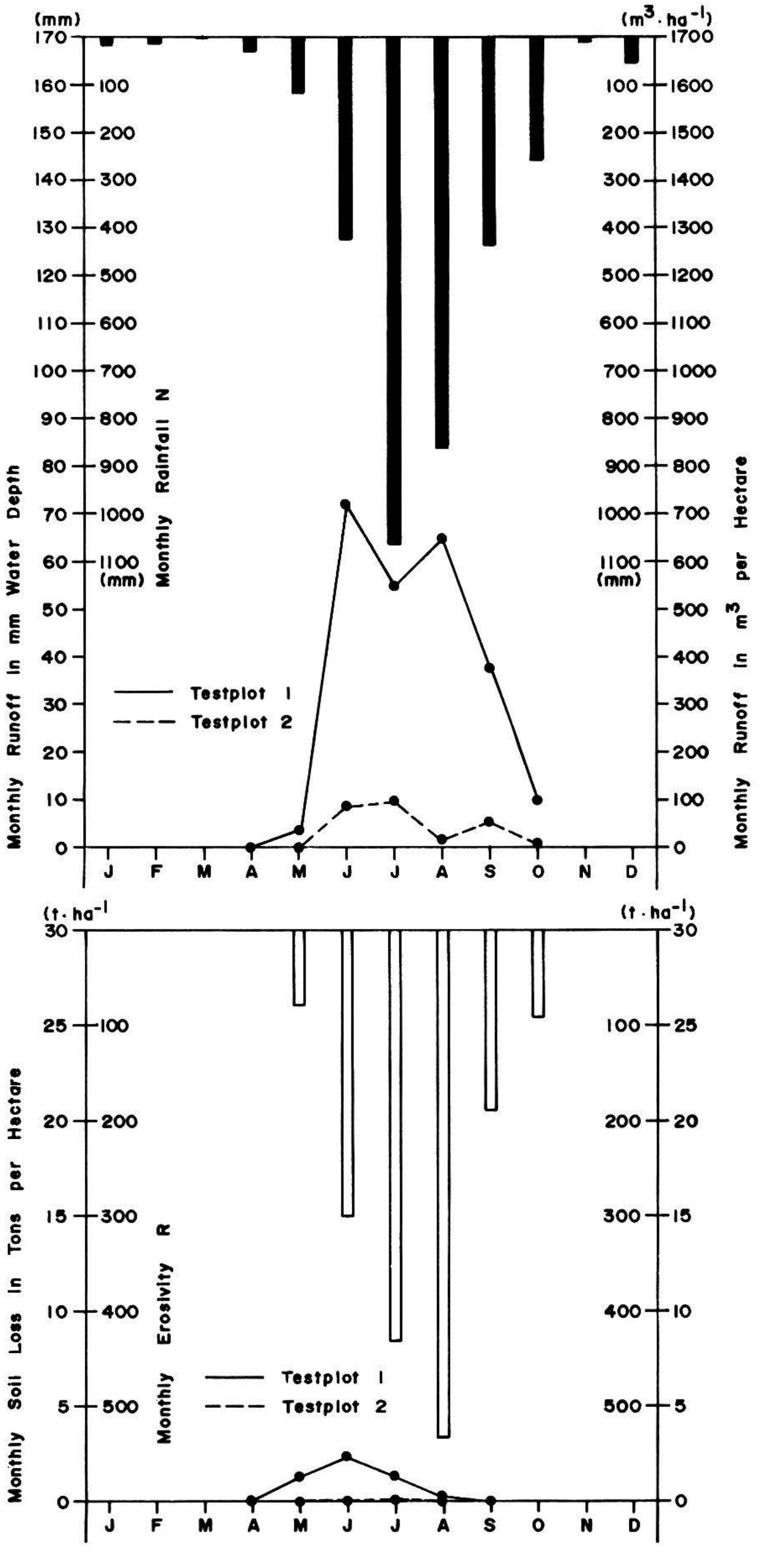


Fig. 4.41. Monthly rainfall, erosivity, runoff and soil loss: Testplots 1 and 2 at Dandapakhar, 1985

Abb. 4.41. Monatlicher Niederschlag, Erosivität, Abfluss und Boden-Abtrag: Testflächen 1 und 2 in Dandapakhar, 1985

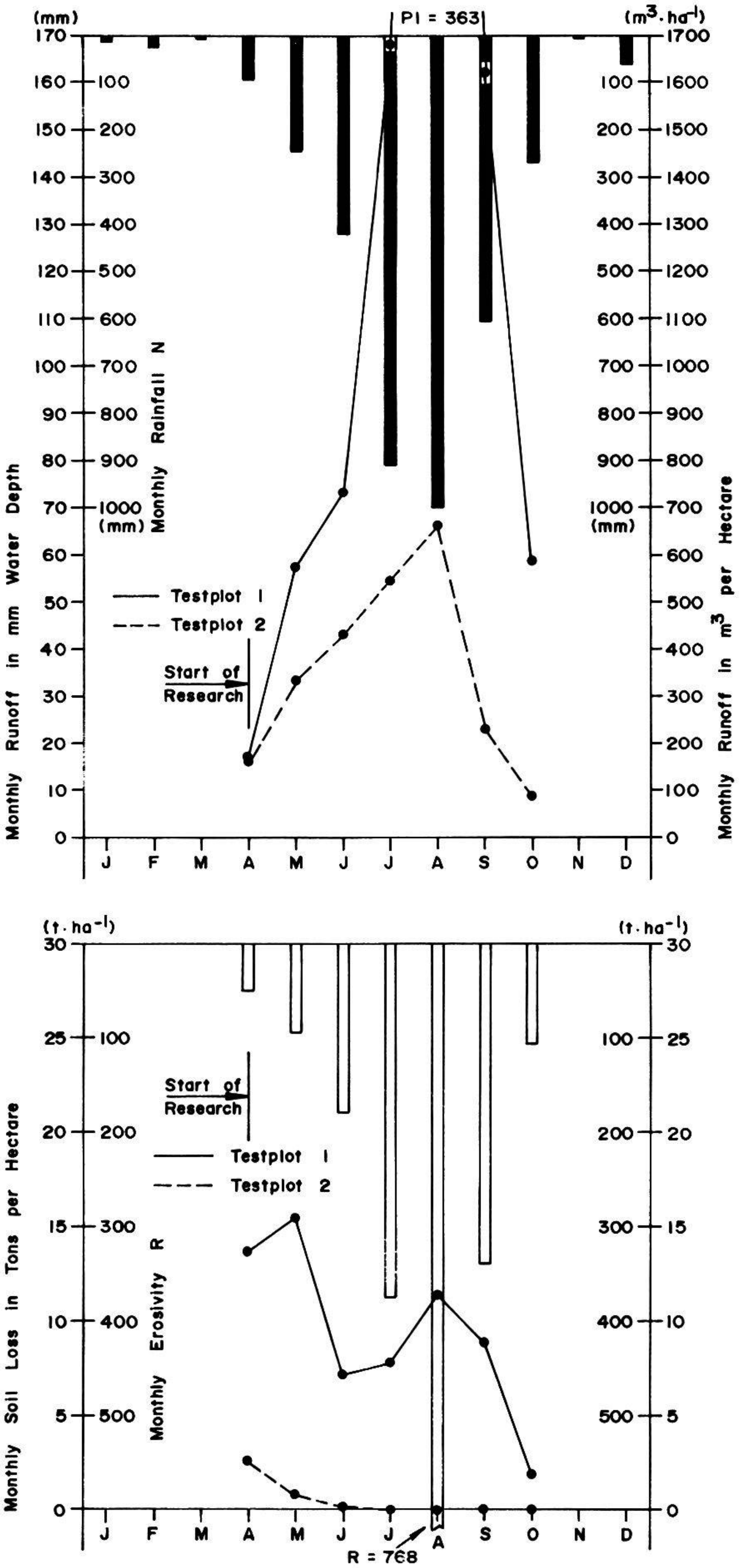


Fig. 4.42. Monthly rainfall, erosivity, runoff and soil loss: Testplots 1 and 2 at Bonch, 1985

Abb. 4.42. Monatlicher Niederschlag, Erosivität, Abfluss und Boden-Abtrag: Testflächen 1 und 2 in Bonch, 1985

4.3.3. Station Bonch

Monthly runoff, soil loss and rainfall erosivity distribution of the two testplots for 1985 are shown in Figure 4.42. The total erosivity is 1912.9 (Joules·cm/m^2·h·100) (Table 4.15, in the pocket of the cover). From September 17-26 the recording raingauge was out of action for clock repair. For this period the data from the simple raingauge - only measuring the amount - were used for the calculations, the intensity was estimated.
Testplot 1, bare, had a high total soil loss of 66.6 t per ha. The runoff was 9001 m^3 per ha, 25.1% of the total rainfall (Table 4.15, in the pocket of the cover). Table 4.16 shows the most frequently weeded species; it gives an idea of the power of natural regrowth.
Testplot 2, overgrown, had only a total soil loss of 3.7 t per hectare. The runoff was 2466 m^3 per ha, which is 6.9% of the total rainfall (Table 4.15). The herb layer covered the plot densely. Table 4.5 (stable area s11) shows the abundance of the species that occurred.
Here too it is evident that dense plant cover decreases runoff and soil loss and thus provides considerable protection against erosion on a steep slope.

5. DISCUSSION

5.1. VEGETATION, REGENERATION OF VEGETATION AND ENVIRONMENTAL CONDITIONS

The rich flora of the Himalaya ist mentioned by POLUNIN and STAINTON (1984) among others - Nepal alone has some 6500 recorded species of seed plants. The high variation of the different types of flora is influenced by many factors. According to the above authors, altitude is the most important of these, followed by aspect and precipitation. In areas affected by the monsoon, the chemical composition of the underlying rock is not of prime importance; only a few species have definite preferences in these terms. The depth of soil and its ability to hold water during the dry season seems to be more important.
In the study area this wealth of flora is reflected in the extensive frequency tables of the stable areas and of the landslides and slopes. The above statements on influencing factors support the division of my plots into four groups mainly according to altitude plus an additional division according to aspect for those plots lying at "middle altitude".
In general, the monsoon climate of East Nepal has a strong positive effect on regeneration. Because of this and the floral variation and diversity, there is a high potential for vegetational regeneration in the subtropical and middle-hill belt of the study area. However, this potential is considerably weakened by the influence of man and animals: the clearing of the forests to obtain land for cultivation or pasture has greatly altered the original composition of the vegetation (NUMATA 1966, DOBREMEZ 1976, KOLLMANSPERGER 1977, POLUNIN and STAINTON 1984). The few forests surviving in the cultivated zone are much changed by cutting for firewood, lopping for fodder, and grazing of animals (PANDAY 1982). Frequent burning in some areas - carried out regularly to improve the grazing - makes regeneration impossible. Uncultivated land around the villages is almost always heavily grazed (NELSON 1980).
An impression of this may be gained by comparing the fenced testplot in Dandapakhar with the surrounding area (Figs. 3.2, 3.3). It must be mentioned that since the afforestation of the whole slope by IHDP in 1983, a watchman has been employed to prevent animals feeding there. In prac-

tice, if this is not done very consistently, a fence would be much more effective. On the other hand, a fence can be pulled down or goats can be lifted over it, both of which happen frequently. NEVILLE (1985) suggests the use of fertilizer in plantations where a watchman is employed, thus accelerating the seedling growth and shortening the period for which the watchman is needed. The best protection, however, is achieved if people are helped to understand the connection between over-exploitation and erosion (NELSON 1980).

All the above does not mean that no "stable" area exists. In spite of the strong adverse influence of man and animals a relatively stable vegetation typical of the exploited regions has developed. For example, the shrubland which covers wide parts of the study area, represented here best by stable areas s6, s7 and s10, seems to maintain a fairly constant floral composition and with its dense plant cover provides good protection against erosion. The testplot results at Dandapakhar demonstrate this fact well. Other examples of stable vegetation are the heavily lopped and grazed forests of Quercus semecarpifolia (stable area s13 and the anchors of plot No. 22, transects 30 and 31) or the mesohygrophilous forests of Schima wallichii such as those in stable areas s4, s5 and s8.

The "stability" of these areas is, however, relative: the flora is continuously being impoverished or changed because of over-exploitation. Although this matter was not intensively studied, it can be seen by comparing the stable areas s4-s7 of the Mati-region. No. s4 is fairly representative of the small remains of a mesohygrophilous forest rich in species. No. s5, lying in the area adjacent to No. s4, can still be called forest, but is exploited: the trees are lopped and animals feed there occasionally. Nos. s6 and s7 next to it are frequently grazed and have been reduced to shrubland with Eupatorium adenophorum dominating. This plant has invaded Nepal from outside (BANERJI 1958), is scarcely eaten by the animals and has thus spread over all pasture-land.

This type of impoverishment can also be shown by comparing the stable areas s1 and s2, both situated in Pinus roxburghii-forest. No. s2 is often burned and regularly grazed; no shrub-layer is able to develop, and the herb layer is relatively poor with some Gramineae dominating. In No. s1, however, burning, grazing and firewood cutting has not been allowed since 1982 (the last burning took place in 1980, after a protection of eight years, GRUENENFELDER 1980a). The rapid development of a

shrub layer is striking and the herb layer is very rich in species.
Lack of regeneration is much more severe in the unstable areas of landslides - natural or man-induced - and slopes. Once the plant cover is removed the fertile soil is quickly washed away by the very heavy rainfalls of the monsoon. The animals - searching for every green leaf in the dry season - loosen the remaining soil with their feet, and this loose soil is also washed away during the next monsoon. Only meagre development of plant cover is thus possible.
One way of solving this problem is protection of the vegetation (NELSON 1980). However, as mentioned above, real protection cannot take place without the co-operation of the people. That such co-operation is possible has been proved in the Pinus roxburghii-forest of stable area sl and in many afforestations of IHDP (GRUENENFELDER 1980a, NEVILLE 1985), but it is not easy to achieve. In this connection the "Chipko Movement" ("Embrace the Tree") should be mentioned, a movement started in Northern India to protect forests from commercial felling (SHIVA and BANDYOPADHYAY 1986). Even if not directly applicable to the conditions in Nepal, it shows that people can become aware of the problem of ecological stability.
Nobody feels responsible for the "no man's land" along the Lamosangu-Jiri road. The animals are usually driven along the road to their pasture-grounds and they feed on whatever is edible along the slopes of the road. To avoid this, fences have been built on very unstable slopes (plots 1, 4, 10, part of 27, 28). The plant regeneration on No. 4 (transect 8) was indeed much more advanced than on No. 5 (transect 9, unprotected) nearby; No. 10 (transect 15) was in much better condition than No. 11 (transects 16-18, unprotected: the different exposition has certainly had some influence too); transect 36 of No. 27 lies in the unprotected part of the landslide and had a lower increase of plant frequencies over the three years of observation than transect 37 which is in the fenced part (additionally planted with Alnus nepalensis and technically stabilized in 1981).
A second possible way to ensure better regeneration on landslides and slopes is the replanting of species that are not eaten. Alnus nepalensis was thus frequently planted or sown directly along the road. This tree combines valuable attributes: it is a pioneer tree able to bind nitrogen, i.e. it grows easily on rough and unfertile ground; it grows quickly (nearly 1 m per year) and roots deeply; it can be easily raised in

nurseries (GRUENENFELDER 1980b); it grows naturally at elevations from 800-2700 m a.s.l.; and last but not least it is generally not eaten by animals. The trees planted grew extremely well. For long stretches of the road this alder shades the slopes and enables a herb layer to develop underneath.

Eupatorium adenophorum was also planted as a cover for the slopes. It too combines many attributes: it grows well on poor land; its evergreen branches cover the soil well; it propagates without problem and it is not eaten by animals. But this species, being a weed, was not used on a large scale because it was opposed by some agronomists in IHDP (GRUENENFELDER 1980a). The Nepali name for Eupatorium is "banmara", which actually means "killer of forest". However, on the testplot in Dandapakhar Eupatorium tended to disappear while other plants thrived once the slope was protected. In my opinion, in unprotected areas "banmara" can only spread widely after the forest has been killed and competition from other plants has been reduced because of overexploiting, e.g. overgrazing. Equilibrium occurs if competition is made possible by protecting the other plants. Thus the name "killer of forest" is not, in fact, justified. A cover of Eupatorium along the road, on the slopes which are by no means considered as pasture-land, could thus be an excellent protection against erosion and grazing.

GREENHILL (1979), after two trial-seasons on landslides in the Bagmati Watershed Project, suggests planting Pennisetum purpureum and Desmodium spp. with reference to the fodder value of these species. But here too the question of priorities arises: A regeneration with fodder species draws the cattle and goats to the place and a fragile young landslide has no chance to regenerate if not strictly protected. Therefore it is much more advisable to first plant non-palatable species to let a slide regenerate and stabilize. After this process it might be possible to supplement plants with higher fodder value.

Regeneration starts with the micro-climate (KOLLMANNSPERGER 1977). By planting and protecting a new vegetational cover on bare slopes, a more balanced micro-climate develops and a greater variation of species will establish themselves. In this respect too, the planting of Alnus along the road has a positive effect.

5.2. DEVELOPMENT AND SUCCESSION

It is obviously difficult to state with certainty a succession after only three years of phytosociological observation (see ref. in KRUESI 1981). Too many factors interfere. Besides man and animals, one of the strongest influences is meteorology, and this in particular showed unusual extremes during the years of the study (IHDP 1976-1985, Fig. 4.39). In order to get a wider time range, the attempt was made to compare the vegetation of landslides of different ages. This too proved to be problematic, as other site factors never fully correspond. KRUESI (1981) suggests the use of phenological data for a better recording of succession in short term research.

Changes in the vegetation are represented in the ordination graphs. It would be dangerous, however, to assert a succession simply by interpreting these graphs: an anchor section might also change over three years and thus on the graph show a trend in a certain direction. It might be more reasonable to state a development trend than an actual succession.

A certain development is, in fact, visible, best shown by the increasing plant frequencies for practically all of the slide and transition sections (Fig. 4.6). The visual impression during the three years of observation definitely proved that plant cover became denser. The appearence of perennials and trees in slide or transition sections indicates obviously a development towards a more stable site since a still moving or disturbed ground would not allow them to settle.

In this connection the ecological studies of the Japanese expeditions should be mentioned. Forests, grasslands and weed communities of eastern Nepal were described and analysed in terms of their distribution, structure and dynamics (NUMATA 1983). The floristic composition of the grassland vegetation of the Arun-river region studied by TSUCHIDA (1983) is at 1100-2600 m a.s.l. quite similar to the composition in the more covered plots and the grasslands of my study; the unpalatable communities, which were often found in unmanaged grassland and the composition of the shrub-type plots are comparable to the shrubland occurring in our region. TSUCHIDA also states the general grassland succession at the same altitude as follows: Grassland-communities change into shrubland (dominated by <u>Eupatorium</u>, ferns, <u>Ageratum</u>, <u>Artemisia</u>, <u>Anaphalis</u> etc.) and

progress through shrub communities (dominated by Eurya, Maesa, Osbeckia, etc. at lower altitude and Rubus, Rhododendron, Viburnum, etc. at higher altitudes) towards warm temperate forests such as Schima, Castanopsis, etc. These findings are to some extent covered by my observations: the Mati-region e.g., mentioned above (Chapter 5.1, Fig. 4.19), could easily be interpreted as grassland succession in the terms of TSUCHIDA. But there I prefer to state an impoverishment and continuous degradation of the floristic composition due to human influence, a process called "retrogressive succession" by TSUCHIDA.
OHSAWA (1983), another member of the Japanese group, gives some hints on dynamic structure and successional stages of forests in the different altitudinal zones, based on three ecological expeditions to the far eastern part of Nepal. He, too, concludes that human activities, including grazing by domestic animals, tree cutting, and fires, have considerable effect upon species composition and structure of the Himalayan forest. OHSIWA observed that on steep slopes, where grazing is difficult, an intact forest has a better chance of survival. It could be inferred, therefore, that a plant society on a former landslide has a chance to develop to a climax, provided protection is granted and a certain stabilization can take place.

5.3. METHODS

The method of stating plant frequencies by laying a fixed transect is efficient and yields quite accurate results (see Ref. in RIPPSTEIN 1985). It registers the increase in the different species in a plot quite reliably even if it gives no information as to the number and the size or age of the species occurring.
To some extent the mathematical processing generalizes the records as it reduces the frequencies, given from 0-100%, to a scale from 0-9 only.
With reference to the question of recording not only the presence per square of a species but also the number of each species (abundance) and in addition noting size or age, I think that for the present study the method used was satisfactory except perhaps for the anchors, rich in species. Here it might not be possible to assess the manifold flora by

just laying a line. But in this case the recordings of the stable areas give an additional idea of the anchor-flora of the different groups.
Some criticism may arise with regard to the soil research performed. With laboratory analysis of only the upper layer of 20 cm and determining the soil characteristics only by augering, the results may not be very accurate for many of the characteristics (Guidelines for Soil Survey and Land Evaluation in Ecological Research, UNESCO 1986). But with the backing of the detailed survey of ESPINOSA (1974, 1975), I decided not to dig soil pits.
When deciding about an erosion model the one used by HURNI in his research in Ethiopia (SCRP 1984) was chosen. This model is well worked out and adapted for a country with similar conditions to Nepal. MORGAN (1981) is sceptical about studies which concentrate on measuring the rates of soil loss under different plant covers and compare them with those measured on bare ground. Based on the results of HURNI I do not think MORGAN's criticism is justified with regard to the erosion model applied in Ethiopia and in this study.
The weekly weeding of the bare testplots probably increased the soil loss slightly, even when after the first clearing there were mainly seedlings to remove. By choosing this method the high regenerating power of such plots was not considered. Digging off the root-layer before the start of the rains could help, but this might disturb the composition of the soil. As a last resort, although reluctantly, herbicides could be used. After all, the disturbance of the soil by weeding can possibly be compared with that of grazing animals on unprotected slopes.

5.4. STABILIZATION VERSUS EROSION

Stabilization of landslides and slopes by plant cover is a much discussed and urgent topic at present. An awareness of the problem has resulted in numerous studies on erosion being carried out. It is stated by different authors that plant cover has a stabilizing effect, by balancing the waterflow and preventing erosion (i.e. SINGH et al. 1967, DONNER 1972, MULDER 1978, NELSON 1980, diff. Reports in TINGSANCHALI and EGGERS 1981, HURNI 1982, HURNI in prep., LAUTERBURG 1985, LAUTERBURG and MESSERLI in prep.).

The problem of erosion and stability of slopes has been investigated by some projects in Nepal (Ref. in LAUTERBURG 1985). FETZER (1977), in his study of the north western mountain ridge of Kathmandu valley, states that the main causes of soil erosion are the highly erosive rainfall characteristics (erosivity), the extreme vulnerability of the soils to erosion (erodibility) and the steepness of the slopes. He suggests to reduce these by building terraces and covering the soil with cultivation.

The Integrated Watershed Management Project (IWM) near Pokhara, under the Department of Soil Conservation and Watershed Management, has already contributed notable research-work concerning erosion problems. In a general basic study an empirical attempt to model the Universal Soil Loss Equation for that region was made (JAHN et al. 1979), since USLE is not directly applicable (IWM 1980). The high erosivity of the rainfall is stated. It was found that the soil loss is very high in early monsoon (IMPAT 1981, GUPTA 1981, CARSON 1985). LABAN (1978) specifies the minimum soil loss with 1-10 t/ha per year; on over-used lands (forests/ grasslands) a soil loss of 20-50 t/ha is estimated. This may increase locally to 200-500 t/ha per year. A well maintained grass/forest cover can be expected to reduce soil losses by a factor of about 9, when compared with overgrazed grassland (IMPAT 1981).

The data measured in my testplots are comparable with the IWM data. The highest soil loss was generally recorded during the early rains before and at the start of the monsoon, with a second peak during August (with much rain of high erosivity) in Bonch. The difference in the amount of soil loss and runoff resp. between a bare and a plant-covered plot is striking. The soil losses of the overgrown plots in Dandapakhar with 3 t/ha (1984) and 0.5 t/ha (1985) and in Bonch with 4 t/ha (1985) are low (presumalby due to protection) if we consider that a reasonably tolerable soil loss of 10-20 t/ha per year is given for well-managed agricultural or grazing land (LABAN 1978). For the bare plots the loosening of some soil by regular weeding may be equated with the disturbance by grazing animals on unprotected slopes. The losses are high for Bonch (on weathered soil) with 67 t/ha in 1985 and Dandapakhar (on dense stone cover) with 16 t/ha in 1984. The low soil loss on the bare plot at Dandapakhar in 1985 with only 5 t/ha may be related on the one hand to the fact that, due to the wooden planks, no soil was able to invade the plot from above, while in the first year of the research much soil was already washed out. On the other hand the lower soil loss in the second year of observation could indicate a certain trend towards stabilization.

The fact that the plots were protected has without doubt influenced the results. To eliminate this influence, the fences and planks could be removed during the dry season and thus open the place to grazing animals. The regeneration of the plots by plant cover would certainly slow down and the soil loss on the covered plots would presumably increase.

Since of the erosion-influencing factors (rainfall intensity and duration/soil/percentage of slope/vegetation), only vegetation can be controlled (SINGH et al. 1967), by all means to improve the conditions for an undisturbed development of a vegetation cover in fragile areas should be tried.

In order to get a certain stabilization more rapidly, natural regeneration can be supported by different measures such as technical stabilizations and the above-mentioned protection or replanting (SCHIECHTL 1980, GEYIK 1983). Considerable effort along these lines was made on the Lamosangu-Jiri road (GRUENENFELDER 1980a, SINGY 1982, SCHLATTER et al. 1982, SCHAFFNER 1985, NEVILLE 1985). Besides the numerous constructions to prevent erosion, great emphasis was laid on regenerating the plant cover on the slopes along the road. The planting of Alnus and Eupatorium is discussed above. They are by far the most promising measures there.

Point-turfing (placement of grass sods) was also carried out on different slopes of the Lamosangu-Jiri road. On slopes with an inclination of less than 75%, planting of Cynodon dactylon-sods was successful (GRUENENFELDER 1980a), and above 2000 m Pennisetum clandestinum developed well; both of these Gramineae are able to resist very high grazing pressure (NEVILLE 1985). The respective plots studied (Nos. 13, 17, 25, 30, 33) do not show a very good development, presumably mainly because the sods were taken from any grassland containing species not especially suitable as pioneer plants on poor soil. The steep incline of the slopes may render their regeneration difficult too. It often happens that the sods remain like small islands scattered over the slope without the plants spreading over it significantly. The soil between the sods is largely washed away and regeneration is thus slow.

Some sowing trials were made along the road and on some plots an adapted technique of hydroseed was applied and a kind of mulching by covering the seeds with Eupatorium twigs and wire netting was tried out (SCHLAT-

TER et al. 1982, BOLL 1983), an erosion control technique also introduced by KRAYENHAGEN (1980). With the exception of Alnus-seeds, these trials did not prove very successful, partly - being unprotected - due to grazing, partly to washing off by the heavy rains of the early monsoon. In any case the expense was not worth the result; three years later there was no measurable difference between a treated and an untreated slope.

Some hope was placed in cuttings of different species. Viburnum erubescens showed promising growth at first. But after some years only a few sticks remained on the slopes along the road, most of them dried up. The majority have been torn out by people passing by for some purpose. Populus monilifera cuttings, recommended already by STEBLER (1970), are promisingly fast growing if planted in good soil. But this restricts their use to a few places along the road.

In planting or sowing trials with other species, special attention must be paid to deep-rooting perennial plants with a good covering effect. They should also not be fastidious about soil (UPHADYAYA 1978). The following species, which partly meet these conditions, showed to some extent a good natural development in the studied plots of the lower and middle altitudes: Hypericum cordifolium, Osbeckia nepalensis, Phyllanthus parvifolius, Gonostegia hirta, Polygonum spp., Chrysopogon aciculatus, Cynodon dactylon, Pogonatherum sp. In the middle and higher altitudes Artemisia sp., Centella asiatica, Hemiphragma heterophyllum, Lycopodium clavatum (on wet slopes only), Arundinella hookeri (very strong roots) and Hemarthria compressa developed notably well. It might be worth carrying out more detailed revegetation trials with a selection of these species.

5.5. CONCLUSION

With its specific geology Nepal is bound to have a great number of unstable areas (SHRESTHA 1980, CARSON 1985). The still occurring uplifting of the Himalayas, the strong downcutting of the rivers, soft geological materials, the weight of vegetation and soil becoming too much (especially in excessive monsoon rains) to hold on long and steep slopes -

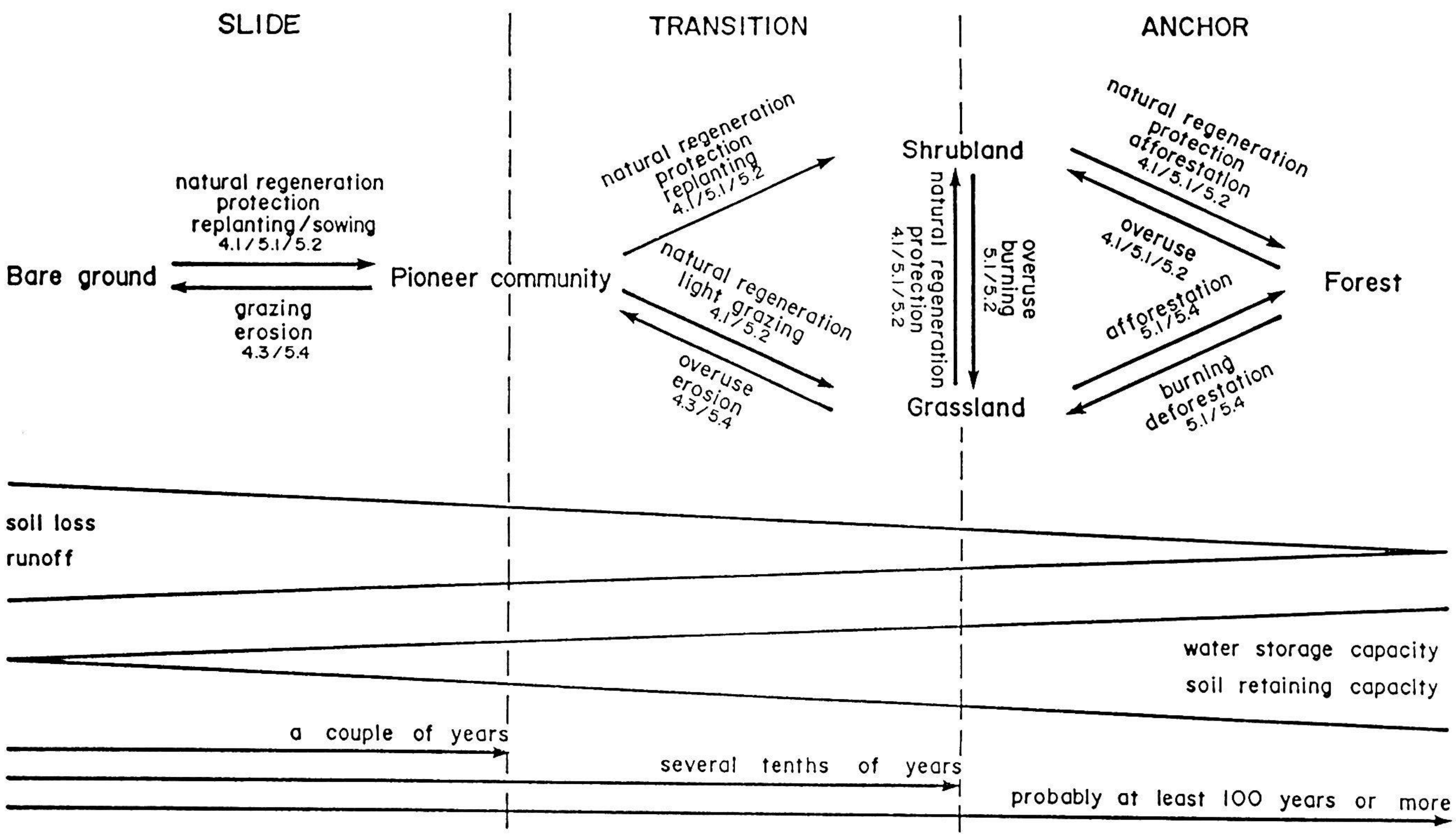


Fig. 5.1. Vegetation-induced dynamics on the studied plots (compare also figures in TSUCHIDA 1983)
Abb. 5.1. Vegetations-abhängige dynamische Vorgänge auf den Untersuchungsflächen (vgl. auch Abb. TSUCHIDA 1983)

these are some factors which influence the stability of a region strongly. Thus only a small part of the occurring landslides are man-induced (DONNER 1972, LABAN 1979). Considering the perhumid conditions of the monsoon climate of eastern Nepal, the question may arise as to whether real stabilization on steep slopes can actually take place. This question might be justified in the "naturally" fragile areas. But with the increasing pressure on marginal land and construction of roads etc. the man-made damages are advancing (NELSON 1980), and here measures can be taken to prevent or repair the destructive forces at work.

One indicator of the stability of a slope is the condition of its vegetation cover (FAO 1983). It is obvious and prove that when this cover is damaged or removed the diverse climatic factors affect the soil. The heavy rainfall during monsoon with its notable erosivity is the strongest factor. To reduce the high soil loss and runoff in crucial regions, first priority should be given to protecting existing vegetation and to replanting or afforesting bare slopes, whether landslides or technically created cuts.

When planting damaged slopes, it is advisable to first use non-palatable or grazing-pressure resisting species, especially if full protection of the area cannot be guaranteed. In this way it could be prevented that any young plant cover is grazed immediately after sprouting. After a certain appeasement of the slide - possibly supported by technical stabilizations - it is still early enough to introduce fodder species.

Figure 5.1 tries to show the vegetation-induced dynamics on eroding and stabilizing steep slopes in eastern Nepal.

SUMMARY

The study presented here, carried out from August 1983 till November 1985 along Lamosangu-Jiri Road in the eastern part of the central midlands of Nepal, deals with plant **regeneration and succession** on unstable slopes (natural or man-induced) and their **possible stabilization.** Special attention is paid to the **erosion problem** of this region.

1. In order to get ideas about regeneration and **development of the plant cover,** 45 transects were laid through 35 landslides and slopes along the road, at altitudes ranging from 1000 to 2600 m a.s.l. The transects were divided into sections according to the different phytosociological conditions. Data was recorded after the monsoon in 1983/1984/1985, at the end of the dry season in 1984/1985 and at the start of the monsoon in 1984/1985. The postmonsoon-data were usually the richest in species, so they are used for the evaluations of development and possible stabilization in the first place. The records from the dry season and early monsoon give additional information on the findings. Due to the wide altitudinal range and the other different environmental factors, the plots are divided into four groups.
   There is a positive **development trend,** best expressed in the strongly increasing plant frequencies, especially in the protected plots, and in the noticeable number of shrubs and trees invading the slide- and transition-sections. Although it is difficult to state a **succession** after only three years of observation (not accounting for the different age of the slides), the invasion by perennial plants can be interpreted as a sign of succession. And this can be judged as a first indication of a stabilization, since succession presumably occurs only after a certain consolidation of a slide.
2. In order to know more about the composition of a possible climax or, at least, of a "stabilized vegetation" comparatively immune to human influences, 13 relatively **stable areas** were recorded too. They are related to the four groups of the landslides and slopes and help to interpret the development trends.
3. **Research on erosion** was carried out at Dandapakhar and Bonch, the locations of two meteorological stations of the Integrated Hill Development Project (IHDP) of the region. At both sites two plots were established - one bare, one covered with plants. The differences between the two plots in runoff and soil loss were evaluated. The data for the uncovered plots proved to be clearly higher than those of the covered plots. The findings are discussed and compared with the data of other erosion research groups in Nepal.
   Landslides and slopes usually carry a relatively **undeveloped soil.** Development of a climax - or in steep slopes rather of a subclimax - can obviously take place only on mature soil. Maturing of the soil, a long process, is additionally slowed down by erosion.

The slopes of the hills of Nepal are - due to the natural conditions - very unstable and exposed to erosion. Since it is evident that erosion is reduced by plant cover, every step should be taken to **protect, maintain, or induce a vegetation cover** on unstable sites. This could be achieved by:

- Protection of the existing or growing vegetation by fencing or employment of watchmen.
- Planting or sowing of adapted <u>Gramineae</u> like <u>Chrysopogon aciculatus</u>, <u>Cynodon dactylon</u>, <u>Pogonatherum</u> at lower altitudes; <u>Arundinella hookeri, Hemarthria compressa</u>, <u>Pennisetum clandestinum</u> (african) at higher altitudes.

- Planting or sowing of unpretentious and, at least temporary, preferably unpalatable shrubs or perennial herbs like Eupatorium adenophorum, Hypericum cordifolium, Osbeckia nepalensis, Phyllanthus parvifolius, Gonostegia hirta, Polygonum spp. at lower altitudes; Artemisia spp., Centella asiatica, Eupatorium adenophorum, Hemiphragma heterophyllum, Lycopodium clavatum at higher altitudes.
- Planting or sowing of pioneer trees like Alnus nepalensis or Pinus roxburghii with the aim of inducing the subclimax of forest communities via the state of grassland or shrubland.
- Technical stabilization, which promotes the re-settlement by plants and in interaction with them helps shorten the unstable stages of a slope.

With these measures much could be done to reduce erosion and to smooth the way for a possible stabilization of a region.

ZUSAMMENFASSUNG

Die vorliegende Arbeit wurde vom August 1983 bis zum November 1985 entlang der Lamosangu-Jiri-Strasse im östlichen Teil des zentralen Hügelgebiets von Nepal durchgeführt. Die Studie untersucht die **Regeneration und Sukzession** von Pflanzen in unstabilen Rutschhängen (natürlichen oder durch Menschen verursachten) und deren **mögliche Stabilisierung**. Gleichzeitig werden die **Erosionsprobleme** dieser Gegend studiert.

1. Um Hinweise über die Regeneration und **Entwicklung der Pflanzendecke** zu erhalten, wurden auf einer Höhe von 1000 bis 2600 m ü.M. 45 Transekte durch 35 Erdrutsche und Böschungen entlang der Strasse gelegt. Die Transekte wurden nach pflanzensoziologischen Gesichtspunkten in die Sektionen Anker, Uebergang und Rutsch aufgeteilt. Es wurden Aufnahmen gemacht kurz nach dem Monsun 1983, 1984 und 1985, am Ende der Trockenzeit im April 1984 und 1985 sowie am Monsunbeginn 1984 und 1985. Die Aufnahmen nach dem Monsun waren vergleichsweise artenreich und wurden deshalb an erster Stelle für die Evaluation von Entwicklung und möglicher Stabilisierung herangezogen. Die Aufnahmen der Trockenzeit und diejenigen von Anfang Monsun halfen mit, die Ergebnisse zu bekräftigen. Wegen der Vielfalt der Standortfaktoren, insbesondere der grossen Höhenunterschiede, mussten die Untersuchungsflächen in vier Gruppen aufgeteilt werden.
   Im allgemeinen zeichnet sich eine positive **Entwicklungs-Tendenz** ab. Diese zeigt sich am deutlichsten in der Zunahme der Frequenzen der Pflanzenarten, speziell in den geschützten Untersuchungsflächen, und in der bemerkenswerten Zahl von Sträuchern und Bäumen, welche die Rutsch- und Uebergangs-Sektionen besiedeln. Auch wenn es nach nur drei Jahren Beobachtung gewagt ist, von **Sukzession** zu sprechen (nicht eingerechnet das unterschiedliche Alter der Rutsche), kann doch die Invasion von ausdauernden Pflanzen als erstes Zeichen einer Sukzession gedeutet werden. Und dies kann als Indikator einer beginnenden Stabilisierung gewertet werden, denn Sukzession kann erst mit einer gewissen Beruhigung eines Rutschhanges einsetzen.
2. Um mehr herauszufinden über ein mögliches Klimax-Stadium, oder mindestens über eine gegen menschliche Einflüsse vergleichsweise immune "stabilisierte Vegetation", wurden 13 relativ **intakte Gebiete** untersucht. Diese Aufnahmegebiete werden mit den vier Gruppen der Rutschflächen in Beziehung gebracht und helfen, die Entwicklungs-Tendenzen zu deuten.
3. **Erosions-Untersuchungen** wurden je in Dandapakhar und Bonch, den

Standorten meteorologischer Stationen des "Integrated Hill Development Project" (IHDP) der Region, durchgeführt. An beiden Orten wurden zwei Untersuchungsflächen eingerichtet - die eine kahl, die andere bewachsen. Der unterschiedliche Abfluss und Boden-Abtrag von den beiden Flächen wurde gemessen. Die Daten für die kahlen Flächen fielen eindeutig höher aus als diejenigen für die bewachsenen Flächen. Die Ergebnisse werden diskutiert und mit Daten anderer Erosions-Untersuchungen in Nepal verglichen.

Erdrutsche und Böschungen weisen normalerweise **unentwickelte Böden** auf. Die Entwicklung eines Klimax - oder in steilen Hängen wohl eher eines Subklimax - kann nur auf reifem Boden geschehen. Der langdauernde Prozess der Bodenreifung ist aber durch Erosion zusätzlich erschwert.

Die Hänge der Hügel Nepals sind infolge der natürlichen Bedingungen sehr unstabil und erosionsgefährdet. Da eine Pflanzendecke die Erosion offensichtlich verringert, sollte jeder mögliche Schritt unternommen werden, um diese **Pflanzendecke zu schützen, zu erhalten oder zu fördern**. Dies könnte erreicht werden durch:

- Schutz einer bestehenden oder heranwachsenden Pflanzendecke durch Einzäunen oder Anstellen eines Wächters.
- Pflanzen oder Säen von angepassten Gramineae wie Chrysopogon aciculatus, Cynodon dactylon, Pogonatherum in tieferen Lagen; Arundinella hookeri, Hemarthria compressa, Pennisetum clandestinum (afrikanisch) auf oberen Höhenlagen.
- Pflanzen oder Säen von anspruchslosen und - mindestens vorübergehend - von ungeniessbaren Sträuchern oder andern ausdauernden Pflanzen wie Eupatorium adenophorum, Hypericum cordifolium, Osbeckia nepalensis, Phyllanthus parvifolius, Gonostegia hirta, Polygonum spp. in tieferen Lagen; Artemisia spp., Centella asiatica, Eupatorium adenophorum, Hemiphragma heterophyllum, Lycopodium clavatum auf oberen Höhenstufen.
- Pflanzen oder Säen von Pionier-Bäumen wie Alnus nepalensis oder Pinus roxburghii mit dem Bestreben, den Subklimax einer Wald-Gesellschaft zu induzieren über die Vorstadien einer Gras- oder Strauch-Gesellschaft.
- Technische Stabilisierung, welche die Wiederbesiedlung durch Pflanzen fördert und im Zusammenwirken mit diesen die unstabilen Stadien eines Hanges verkürzen hilft.

Mit diesen Massnahmen könnte einiges dazu beigetragen werden, Erosion zu verringern und den Weg zu ebnen für die mögliche Stabilisierung einer Region.

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Table 3.1. The studied landslides and slopes and their characteristics
Tab. 3.1. Die untersuchten Erdrutsche und Böschungen mit ihren Eigenschaften

mon = monsoon, dry = dry season, sl = slide, disp = disposal

Study plot	Transect No.	Vegetation type of anchor	Altitude a.s.l.	Aspect 0-400°	Slope %	Type	Occurred	Stabilization measures
1	1- 3	mesohygrophilous forest	1120	375	65	slide	mon 80	technical/fence/ Alnus
2	4- 6	mesohygrophilous forest	1180	375	68	slide	mon 77	technical
3	7	xerophilous forest	1450	225	80	cut/sl	mon 80+81	technical/ Alnus + Eupatorium
4	8	shrubland	1690	150	70	disp	dry 76/77	technical/fence/ Alnus
5	9	shrubland	1690	200	70	disp	dry 76/77	-
6	10	mesohygrophilous forest	1810	250	80	cut/sl	mon 81+82	technical
7	11	Pinus patula-afforestation	1970	300	85	slide	mon 81+82	-
8	12-13	hygrophilous forest	1990	350	90	slide	mon 79	-
9	14	shrubland/hygrophilous forest	1990	75	90	cut/sl	dry 77/78	-
10	15	shrubland/hygrophilous forest	2010	400	75	disp/sl	dry 77/78 mon 80	technical/fence/ Alnus
11	16-18	shrubland/hygrophilous forest	2040	250	85	disp	dry 77/78	technical/ Alnus
12	19	shrubland/hygrophilous forest	2040	200	75	slide	ca. 1955	-
13	20	shrubland/hygrophilous forest	2090	250	80	cut/sl	dry 77/78 mon 78	technical/ Alnus + point turfing
14	21	hygrophilous forest	2120	25	65	slide	mon 78	-
15	22	hygrophilous forest	2170	325	95	cut/sl	mon 78-80	technical/ Alnus + var. seeds
16	23	pasture land	2570	250	75	disp	dry 77/78	-
17	24	pasture land	2620	100	90	cut	dry 78/79	fence/ point turfing
18	25	pasture land	2560	125	78	cut	dry 78/79	technical
19	26-27	pasture land	2500	150	90	disp/sl	dry 78/79	-
20	28	pasture land	2500	150	85	disp	dry 78/79	Alnus
21	29	pasture land	2530	150	95	cut	dry 78/79	technical/ Alnus
22	30-31	mesohygrophilous forest	2550	275	73	slide	mon 82	technical/ Alnus
23	32	mesohygrophilous forest	2440	275	90	disp	dry 78/79	Alnus
24	33	mesohygrophilous forest	2350	200	70	slide	mon 82	technical/ Alnus
25	34	shrubland	2100	50	80	cut	mon 78/79	technical/ Alnus + point turfing
26	35	shrubland	2100	125	73	cut/sl	dry 78/79 mon 79	technical/ Alnus
27	36-37	shrubland	1975	175	50	slide	ca. 1970	technical/fence/ Alnus
28	38	shrubland	1950	210	70	slide	mon 83	technical/fence/
29	39	shrubland	1890	250	85	disp	dry 82/83	Alnus
30	40	shrubland	2050	290	95	cut	dry 78/79	point turfing
31	41	shrubland	2020	300	75	disp	dry 78/79	-
32	42	shrubland	1800	175	70	disp	dry 78/79 dry 82/83	Eupatorium + Alnus
33	43	shrubland	1750	200	112	cut	dry 78/79	technical/ var. seeds
34	44	mesohygrophilous forest	1730	200	80	disp	dry 78/79	Alnus + Eupatorium
35	45	mesohygrophilous forest	1730	300	80	disp	dry 78/79	Engelhardtia

Veröff.Geobot.Inst.ETH,Stiftung Rübel,Zürich, **93** (1987)
R. SCHAFFNER: Vegetation of stabilizing and eroding slopes in eastern Nepal.

Table 4.1. Plant composition and frequency, group 1, last survey (October 1985)
Tab. 4.1. Zusammensetzung und Frequenz der Pflanzenarten auf den Untersuchungsflächen der Gruppe 1, letzte Aufnahme (Oktober 1985)

○ = Slide section, △ = transition section, □ = anchor section
+ = plant frequency of 1%
1 = plant frequency up to 2.5%, 2 = 5%, 3 = 7.5%, 4 = 10%, 5 = 20%
6 = 30%, 7 = 50%, 8 = 70%, 9 = 100%

PLANT COMMUNITY	TRANSECT NO	1	1	1	2	2	3	4	5	6	4	5	4	7	2	1	7	7	4	4	1	2	5	7	7
	SECTION NO	2	3	4	2	3	1	3	1	1	4	2	2	3	4	5	2	4	1	5	1	1	3	1	5
	SECTION SYMBOL	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	□	□	□	□	□	□	□
	NO. SPECIES																								
general slide community rather unstable	357 VANDELLIA SP.	5	2	3	5		1							+							3				
	79 CYPERUS ROTUNDUS		3				1	1																	
	72 CROTALARIA SESSILIFLORA		2		3		+																		
	6 ALNUS NEPALENSIS (cult.)	7	8	7	5	7	7							5											
	93 DIGITARIA SP.				3			1	2	1	+			1											
	84 DESMODIUM CONCINUUM	2	2	7	5					1	3	2							3						
	119 ERIGERON FLORIBUNDUS/MULTICAULIS					3	1			1				+											
	69 CRASSOCEPHALUS CREPIDIOIDES				3	1	1		1		+														
	214 CERATODON PURPUREUS	4	3			1	+	2			1	2													
	273 POGONATUM JUNGHUHNIANUM		2	7		+	1	2	1	4	5														
	191 PHILONOTIS TURNERIANA					5	1		2	5	2												5		
general slide community rather stable	306 JAMESONIELLA SP?	5	5	8		5	5		3	5	6	5				5				2	2				
	313 SCHIZACHYRIUM BREVIFOLIUM	2	7	6	5	5	6	5	7	6	7	2		5		8			1	5					
	240 OSBECKIA NEPALENSIS	4	6		7	5	5	5	5	6	5		5	5	4			5		2		3			3
	225 MURDANNIA NUDIFLORUM		2				1	5	6	6	2		2	1		6			5	2					
	234 OLDENLANDIA CORYMBOSA		2	3			2							1							2			3	
	17 ARTHRAXON LANCIFOLIUS			5				2	5	4	+								3	2	2	2			
	154 GLOCHIDION VELUTINUM				3			2		+									3			3	3		
	46 CAPILLIPEDUM ASSIMILE			3	3		1			+						7			6			6			
	312 SCHIMA WALLICHII			3		+	1			+					9					7	7				
	138 FIMBRISTYLIS DICHOTOMA					+	3	6	6	6	6			2					2			2			
	194 KYLLINGA BREVIFOLIA					+		2	1	1									5						
	359 VERNONIA CINEREA/CONYZA JAPONICA					2	2	4	2	5	1		2	1					1	5	3	5			3
	302 SACCIOLEPIS INDICA						2	1	5	1	1		7	6				5	2						6
	217 MELASTOMA NORMALE						+	4	5	4	+	4		+					3						
	318 SELAGINELLA SP.						+	1	2	1	+		2						5						
	219 MICROMERIA BIFLORA								2	1	2			2			6							1	3
	248 PASPALUM SCROBICULATUM						+	2	2	3				5					2					3	5
older slide community rather wet	181 DRYMARIA DIANDRA						+	7	7	6	1		4												
	18 ARTHRAXON QUARTINIANUS							3	2	3	+											2			
	77 CYPERUS ARISTATUS							1	3	3	3					5									
	40 BULBOSTYLIS CAPILLARIS							2	1	2			2												
	121 ERIOCAULON NEPALENSE							2	2	2	1														
	147 GENTIANA CAPITATA							2		3	2														
	171 HYPERICUM JAPONICUM								2	5	2			5											
	85 DESMODIUM CONFERTUM									2	2	4	6						2						
anchor group, aspect NNW shrubs, overexploited forest	132 DRYOPTERIS MARGINATA									+	3	2							1	2	2	2			
	48 CAREX CRUCIATA										1								3	5					
	345 SYZYGIUM CUMINI											5							2		3				
	90 DICRANOPTERIS LINEARIS				5						+	2									7	9			
	22 ARUNDINELLA NEPALENSIS						1	1		1				1					1		5	2			
	324 SHUTERIA INVOLUCRATA						+														2	2			
	99 DIOSCOREA GLABRA					2				2					5				2		2	3			
	242 OSYRIS ARBOREA										+									2	5	6			
	111 ENGELHARDTIA SPICATA				5				1		1	5									6	7			
	367 WOODFORDIA FRUTICOSA						1				2		5									3	3		
	52 CASTANOPSIS INDICA							4		5						7							5		
	349 THELYPTERIS MULTILINEATA									1											2		5		
	352 ORCHIDACEAE SP.										+								2				5		
	146 GENIOSPORUM COLORATUM						+			1	2												3		
	128 EURYA ACUMINATA								1	2		5											3		
	300 PTYCHANTHUS SP.							1		3	4		2						5	4			3		
	281 PTERIDIUM AQUILINUM				3					3				+			7	7	3	5		5	6	5	
	170 HYPERICUM CORDIFOLIUM				3		+		3		5	4	2	5		5	7		5	2	4	6	7	3	
anchor group, dry Pinus roxburghii	279 PRUNELLA VULGARIS				5									3		5	7				4	2		6	6
	258 PINUS ROXBURGHII													6		7		9						6	9
	96 DIGITARIA SP.													5				5						5	3
	181 INULA CAPPA									+				1			5							4	5
	35 BIOPHYTUM SENSITIVUM													5			7	5						8	
	127 EUPHORBIA HIRTA				3									1		5	7	5						5	3
basic species group	180 INDIGOFERA DOSNA				3	+	3	5	5	6	4		4	6			6	9	5					7	8
	3 AGERATUM CONYCOIDES		2				1	4	4	4	+			1		5	7	7	2	2	2	2		7	
	177 IMPERATA CYLINDRICA		5		6	3	5	6	6	6	3			+					1	7	8	8	3	7	
	57 CHEILANTHES FARINOSA		5	5		+	4	1		+	5	6	7	2			5	7	5	4	5	6	6	7	7
	126 EUPATORIUM ADENOPHORUM	5	8	9	7	8	8	9	9	9	9	8	8	7	9	9	8	7	9	8	6	6	7	9	7
	262 POGONATHERUM CRINITUM/PANICEUM	9	9	9	9	9	9	8	7	9	9	9	9	7	8	9	7		9	9	9	9	9	7	
	38 BRACHIARIA VILLOSA	2	3	3	5	5	4	2	4	2	+		2	6		6	8	5	2		4	3		6	7
	156 GONOSTEGIA HIRTA		7	6	5	6	2	6	5	4		5	5	1	5	8			3	5	2	5	6	5	
	305 POGONATUM SEMINUDUM		3	5	3	2	5	6	6	6	7	8	8	5	6					6	3	2	6		
	253 PHYLLANTHUS PARVIFOLIUS		5	5	3		2	5	6	7	8	8	5	1		5			5	7	4	5	8		
	232 NEPHROLEPIS CORDIFOLIA		2		5		1	5	5	6	5	8	5		7				8	8	3	7	8		
	218 LYONIA OVALIFOLIA			7	5	2				2	5	7							5	7		5	7		
	336 SPOROBOLUS PILIFERUS		3	3			1			1				2				5	1					1	7
	233 BORRERIA STRICTA		5	5			1				3					6	7	8		4				7	5
	354 TRIUMFETTA PILOSA		3				+							+			4	7						5	3
	158 HACKEOCHLOA GRANULARIS		5			+	1															2			8
unspecific or rare species	34 BIDENS PILOSA		2							+														2	
	28 BARLERIA CRISTATA		2												5							3			
	293 RHUS JAVANICA	5		3				2		2										2			5		
	316 SCUTELLARIA DISCOLOR					+			1											2	2				
	94 DIGITARIA ASCENDENS						+		1												2				
	102 DRYOPTERIS CHRYSOCOMA							2		1	+														
	222 MICROSTEGIUM VIMINEUM								2		2								3						
	117 ERAGROSTIS UNIOLOIDES								1	+	+														
	237 OPLISMENUS COMPOSITUS/BURMANII									+									3		2				
	325 SHUTERIA VESTITIA									+				1					1					5	
	33 BIDENS BIPINNATA													1			5				2	2		7	
	320 SETARIA PALLIDE-FUSCA													2			5							7	
	188 JUSTITIA PROCUMBENS																	5	2						3
	SECTION GROUPS	slide group													tran-sition				anchor group						
	CHARACTERISTICS OF SECTION SUBGROUPS	younger aspect NNW techn. stabilization; Alnus cult.						older aspect NNW wet; Drymaria Cyp. arist. Eriocaulon						aspect SSW, dry					shrubl. asp. NNW over-exploit.; Engelh. Schima Osyris Hyp. c. Pterid.					Pinus roxburghii-forest aspect SSW, dry	

Species only found in one or two sections:

Anchor: Castanopsis tribuloides, Quercus glauca, Maoutia puya, Eriocaulon nepalense, Gerbera sp., Indigofera atropurpurea, Labiatae 2, Taxithelium sp?, Chlorophytum nepalense, Dioscorea bulbifera, Smilax sp., Clematis sp., Labiatae 1, Stephania sp., Commelina paludosa, Cyperus globosus, Eragrostis papposa, Oxalis corniculata, Laggera alata, Sonchus asper, Premna sp., Calaminthe umbrosum, Crotalaria humifusa, Desmodium microphyllum, Sida rhombifolia, Eriosema chinensis, Scutellaria repens, Borreria latifolia

Transition: Viola serpens, Cynoglossum sp., Scutellaria repens, Borreria latifolia, Labiatae 2

Slide: Arthromeris sp., Hedyotis scandens, Pavetta tomentosa, Gerbera sp., Polygonum capitatum, Mouttia puya, Crotalaria albida, Taxithelium sp?, Indigofera atropurpurea, Quercus glauca, Dioscorea bulbifera, Eragrostis atrovirens, Rubus ellipticus, Isodon striatus, Sporobolus fertilis, Equisetum diffusum, Anaphalis triplinervis, Osbeckia stellata, Lycopodium clavatum, Litsea polyantha, Digitaria violascens, Cyperus sanguinolentus, Anaphalis contorta, Ficus cunia, Oreocnide fruticosa, Zornia gibbosa, Oxyspora paniculata, Roscoea purpurea, Fraxinus floribundus, Chrysopogon aciculatus, Onychium siliculosum, Eragrostis papposa, Sonchus asper, Calaminthe umbrosum, Desmodium microphyllum, Cynoglossum sp., Sida rhombifolia

Table 4.2. Plant composition and frequency, group 2, last survey (Oct. 1985) (for legend see Table 4.1)

Tab. 4.2. Zusammensetzung und Frequenz der Pflanzenarten auf den Untersuchungsflächen der Gruppe 2, letzte Aufnahme (Okt. 1985) (Legende siehe Tab. 4.1)

PLANT COMMUNITY	TRANSECT NO	1	1	3	3	4	4	4	3			3	3	3	3	3	3	3	4	3	3	3	4	1	4	4	4	3	3	4	4	3	4	4	4	4	1	1	4	1	3	3	3	4	4	4	3	3	4	1	1
		1	1	5	9	4	5	1	9	9	8	7	6	6	6	6	7	9	3	4	5	8	2	0	0	1	2	5	5	2	2	8	1	5	5	4	0	1	0	0	7	8	5	2	4	5	4	8	1	1	1
	SECTION NO	3	4	4	2	3	3	2	3	1	1	2	2	4	1	3	3	1	1	3	3	2	4	2	1	1	3	2	5	2	5	3	3	4	2	4	3	5	2	1	1	1	6	1	5	5	5	4	4	1	6
	SECTION SYMBOL	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△	△	△	△	△	△	△	△	□	□	□	□	□	□	□	□	□	□	□
	NO. SPECIES																																																		
dispersed slide community with variation of region	225 MURDANNIA NUDIFLORUM							2	1	2		1			+		2																			5										
	69 CRASSOCEPHALUM CREPIDIOIDES			1					5	+	+		1	3	2	2		5														5		2								1									
	33 BIDENS BIPINNATA								6	3	1							2	1				+																			3			3							
	194 KYLLINGA BREVIFOLIA									+	2		1	5	3	2	1		+			4		1		+	2																4								
	298 RUBUS ELLIPTICUS				2											+	1	6		+	1			+	+	2															2			6								
	234 OLDENLANDIA CORYMBOSA					+						1	1					2	5				+	1		+	3												2		3									
	144 GALIUM SP.											1			4		2	2						1									5											5	1						6			
	60 CHRYSOPOGON GRYLLUS											7	5	2	2	4	7	5	7	1							2														7									
	301 SACCHARUM SPONTANEUM											5	7	7	2	5	7		3	5		4																				7									
	46 CAPILLIPEDIUM ASSIMILE											1	5			4	7	2										+																4									2	
	119 ERIGERON FLORIBUNDUS/MULTICAULIS												1			3		+	1			1			+																	5											
	80 CYPERUS SANGUINOLENTUS												1	5	2	2		2																																	
	42 CALAMAGROSTIS PSEUDOPHRAGMITES												2		5	5	5																																		
	34 BIDENS PILOSA				2			2	5								+																																		
	79 CYPERUS ROTUNDUS				4													1	1			2																													
	264 POLYGONUM CAPITATUM									3	6								+											7															3							
	68 CONYZA STRICTA				2					+		2						+						+		+														2											
	3 AGERATUM CONYZOIDES								2		5							1						5		+											5			6	3									
	170 HYPERICUM CORDIFOLIUM									3	5													3							6	2					6	8			6									5		
	243 OXALIS CORNICULATA						1	3			+	1								3	1					3	4	+			5					2				2				2								
	77 CYPERUS ARISTATUS																					2	6			+	4			5																				
	54 CENTELLA ASIATICA							3							1				2	2	4				5		7				2	4										3						2			
	115 ERAGROSTIS ATROVIRENS			6		2	1			+	2							+	4	1	3	3		6	5	2			5			2	4																2			
	266 POLYGONUM NEPALENSIS				5	1		2										1	+		1		2			2	4			6	2																		5			
	283 PYRACANTHA CRENULATA	4			2							1				+		2			1	1		+		1	+										9			2		3									
	94 DIGITARIA ASCENDENS				3	+		4	2	+					1		+	5								6	3		5	6						7			5				2							
	353 TRIPOGON FILIFORMIS		3							+		3	2			+					2					3														5			5									
general slide community	359 VERNONIA CINEREA/CONYZA JAPONICA					5	3			1						+	+	1	2	+	1	1	+	2	2	2								2					3	2						5					3
	171 HYPERICUM JAPONICUM					4	4			+	4			3		1			2	3	1	4		5	2	1														2	2											
	116 ERAGROSTIS PAPPOSA/NIGRA					+		3			1			2	1		2	+		3	5			2	+	5			5						2				1	5									3			
	74 CYANOTIS VAGA/AXILLARIS					1	1		5	6	5	1			2			4	4	1			4	1	3		5			6						5			5	3	6	4					4				
	358 VANDELLIA NUMMULARIFOLIA			4	2	1			5		2	1				+	1	3	3	3	3	3	+	5	1	1	+		5			5								3	3	3	1				4				
	138 FIMBRISTYLIS DICHOTOMA					1	1				1			6	4	+	+	4	1		1	6	+	+			+								2				5	2		1									
	313 SCHIZACHYRIUM BREVIFOLIUM			3				4				2		2				5	6	2	3	1			8	1		5	5				5						9	2		3									
	17 ARTHRAXON LANCIFOLIUS			1					7	3	5	5	1	3	2	2		5	8		4	2	+	2	6	+	1		7	5							7		4	3	6									
	101 DRYMARIA DIANDRA				5		1		8	5	2	1	7	3	9	5	4	8	2		5	5	5				6			5		7									7	7							3			
	219 MICROMERIA BIFLORA											1			1				6	+				4	6	2											7		3	5	5									
transition commun.	240 OSBECKIA NEPALENSIS				3	4	4			5	6	1	5	8	6	7	6	+	5			2		5+		2+				3	2		4	5	2		5		3						4							
	248 PASPALUM SCROBICULATUM				2	3	2	5	3	1	3				3			4	2	1		3	+	5	1	5	3	5	6	6	3		5		4				5	7			4								
	6 ALNUS NEPALENSIS (partly cult.)	2	7	4		8	7				7	6	9	7	7	7	9	6	5	2	6	7	+	+		4	7	8				8		6	2							9						3			
	40 BULBOSTYLIS CAPILLARIS			2		5	6		8+		2	5	4	6	5	6		5	6	3	2	5	4	1	6	2		5	5	6		4		2					6		5	1	5			5					
	9 ANAPHALIS CONTORTA	6	8	2	4			7			+	7	4	5	4	5	1	2	5	7	4	4		5	9	7		9	9				6		4		7	7	7	8	8	5	4							2	
	214 CERATODON PURPUREUS	5	6			5	1			+	+	1	5	2	5	4	1	+	5	1	5	1	+		2		4				2								2	2					7	3					
	273 POGONATUM JUNGHUHNIANUM	9	7	9	5	3	5	7	7		1	5		5	1	2	2		2	8	8			6	9	8		7	8				5	7	8		7	5	3	6	3	1		2	7	6				2	
anchor community	30 BERBERIS ARISTATA/ASIATICA					1	1						1		2			1		1	+	2	2	5	+			+			7	9	4							2			5		5		3		6	8	2	
	241 OSBECKIA STELLATA			4			1			+										2	2			1	2				6				4		4			5	3	2		2	4	5			7			6	5
	318 SELAGINELLA SP.								2							2		2		+	+		3		2	2	+						7	4				7	5		3	8	8	7					7	4	2	3
	312 SCHIMA WALLICHII															1				1					3								3		5							2						5			5	2	5
	128 EURYA ACUMINATA									+														4							7				5					5				7						7	5
	292 RHODODENDRON ARBOREUM						2									+						1													7	2									6	7	7			2	
	300 BRACHYTHECIUM VELUTINUM																							+									5																8	8	2	6
	281 PTERIDIUM AQUILINUM									2	4																																				3	4			2	3
	57 CHEILANTHES FARINOSA										2	1					+																		2						5								2	3
	90 DICRANOPTERIS LINEARIS																	1																			8		8		6					9					8	7
	339 STROBILANTHES ATROPURPUREUS	4																																			8	8		5									7	8
	289 RANDIA TETRASPERMA																																					5										9	4		5	
	181 INULA CAPPA																									+															2										4	5
	295 ROSCOEA PURPUREA		3																			1			+	+														4						4		5		7	2	3
	58 CHLOROPHYTUM NEPALENSE																										+																			4		5			4	
	48 CAREX CRUCIATA															+		1			3																							5				8	6		7	2
	252 PHYLLANTHUS FLUEGGEIFORMIS																					2																				5	5							6	6		
	24 ATHYRIUM ATKINSONI															+																													8						2			
basic species group	126 EUPATORIUM ADENOPHORUM	4	6	2	8	9	9	9	8	9	8	9	8	8	9	7	9	9	7	6	8	8	9	5	6	7	9	9		9	9	9	8	9	9	9	5	5	7	8	6	9	9	9	4	8		9	8	6	7
	305 POGONATUM SEMINUDUM	2	5		2	6	7	4	7	3	5	1	2	6	6	4	+	1	1	1	4		5	5	2	2	6			7	3		4	9			7		4	5				2		7				2	6
	262 POGONATHERUM CRINITUM/PANICEUM	5	8							1	5	6	1	6	6	6	3		3	3		5		+	2	+				3	3	8	6		5	5		8	3	6	5	3		9	8	5		9	9	5	9
	22 ARUNDINELLA NEPALENSIS	7	9	5				6		1		8	7	6	7	6	7	3		6	3	7			7	2	3		6			9	7	5			5	7	5	5	8	9					9	7	4	5	6
	336 SPOROBOLUS PILIFERUS			6	7	9	9	6	6	5	7	8	5		4	1		7	7	5	3	1	8	7	7	6	8	8	7	7		4	5	7	2		9		7	7	6	2	7			5		3			
	38 BRACHIARIA VILLOSA			1	7	6	8	6	7	3	5	4	6		2		+	6	2	5	2	1	5		4	6	7	5	6	6	3	2	6	5	2		5		7	2	5	4	6									
	302 SACCIOLEPIS INDICA			4	3	2	4	2	5		5	5	7	8	6	7	7	6	2	4	5	6	5	2	1		6	5	9	7		7		2		5	5		2	5	5	7	5	2		6			5	2	
	177 IMPERATA CYLINDRICA						7	6			+	5	6	6		+	7	5	2	4	2			+	7	3	1				4	2	5		2				9	7	8	1		5				3	6		
	156 GONOSTEGIA HIRTA				2	1		5			3						2	3	1	1	3			1	2	2						5	2	7			8	9	5	7		7	7	7	6		6	8				5
	189 CAMPYLOPUS SP.	2	7		2	5	8	2	5		1							2						2	8		1							7	4			8	7	5						5				4	6
	210 LYONIA OVALIFOLIA	4	5				2				+	3	3			2	1			+	1	3									3	5	7		5	6						5	4		9	9		7		5	5
	145 GAULTHERIA FRAGRANTISSIMA	2	6	1						+						1					1	3				4	1		5	5				8					5	7	5				7		7	9	3	9	7	5
	253 PHYLLANTHUS PARVIFOLIUS	5	3				5			1									7					3	+		+			5	4	2			9		5			7				7	7				5	8	2
	145 GENTIANA CAPITATA	5	5						2			2		2						+	1			+		3	+				5										4		5										3
unspecific or rare species	130 EURYA JAPONICA	2																							+																													2
	244 OXYSPORA PANICULATA		3										3			1																																			
	125 EULALIA SP.		3								1																																			5						
	110 ELSHOLTZIA PILOSA			6																	2								6														1								
	331 SMITHIA CILIATA			4													+		5	2									7														1								
	143 GALINSOGA PARVIFLORA/CILIATA								7									1																									5									
	320 SETARIA PALLIDE-FUSCA					1					+							1								2									2	5														
	166 HETEROPOGON CONTORTUS										1								+																										2							
	70 CROTALARIA ALBIDA											4				+																									3										
	159 ANTHOCEROS SP.						3						1		1				2																		6														
	335 SPOROBOLUS PILIFERUS										+								2																									3								
	4 AGROSTIS PILOSULA												1			+				1																															
	163 HEMARTHRIA COMPRESSA									2								1					3																					3								
	87 DESMODIUM MICROPHYLLUM											5						1	2								1														3	1								
	71 CROTALARIA HUMIFUSA						1					2									3		1				1												2										
	269 POLYGONUM SPHAEROCEPHALUM												5																5														3	4							
	137 FICUS NEMORALIS																	1	1						+																	3								2		2	
	16 ARTEMISIA SP.																	1	+				1				1																									
	18 ARTHRAXON QUARTINIANUS																			2																										2	5							
	114 ERAGROSTIELLA BIFARIA																		8											5															2							
	180 INDIGOFERA DOSNA																		5					+																						2			8				
	10 ANAPHALIS MARGARITACEA					2												+		2														2																
	49 CAREX DALTONII/LONGIPES																		2		1			+	2																2										2	2
	284 PYRUS PASHIA																		2				1				2				8								5											
	342 SWERTIA SP.																			1	5																													2	
	173 HYPERICUM URALUM																				1			+						6																8							
	267 POLYGONUM UNCINATUM				2															1	3																						2	4					2			
	26 ATHYRIUM SP.								3												1																								4						2			
	184 ISODON STRIATUS																								+							2								2											
	56 LABIATAE 1					1	1																																							5	6					
	229 MYRSINE CAPITELLATA																																	5		5									6	8					
	SECTION GROUPS	slide group																									transition group													anchor group										
	CHARACTERISTICS OF SECTION SUBGROUPS	unspecific poor in species unstable or poor ground, rather dry										typical more stable or better soil rather wet Polygonum, Eragrostis, Vandellia Drymaria, Arthraxon																Osbeckia nepalensis Anaphalis contorta Paspalum scrob.													pasture-shrubland-poor forest Berberis Osbeckia st Eupatorium						shrubl.-forest Schima Eurya				
												variation of region: Saccharum Chrysopogon Calamagrost.																																							

Species only found in one or two sections:

Anchor: Pinus patula (Sp.no 257), Eurya cerasifolia (Sp.no 129), Eriobotrya dubia, Lepisorus bicolor, Gerbera maxima, Vitis lanata, Viburnum coreaceum, Quercus lanata, Desmodium confertum, Viburnum stellatum, Castanopsis tribuloides, Spheromeris chinensis, Leucostegia immersa, Smilax menospermoidea, Orchidaceae sp., Begonia sp., Rhus succedanea, Strobilanthes sp., Leucas mollissima, Rhodobryum giganteum, Melothria heterophylla, Neillia thyrsiflora, Crypsinus ebenipes, Flacourticaceae sp., Shuteria involucrata, Pavetta tomentosa, Polystichum squarrosum, Microstegium nudum, Carex atrata, Arisaema costatum, Symplocos crataegoides

Transition: Polygala triphylla, Eulalia sp., Melastoma normale, Hedyotis scandens, Pavetta tomentosa, Erianthus rufipilus, Shuteria vestitia, Zingiberaceae sp., Prunella vulgaris

Slide: Polygala triphylla, Leucas mollissima, Elsholtzia blanda, Eulalia sp., Melothria heterophylla, Shuteria involucrata, Taraxacum sp., Shuteria ferruginea, Pinus roxburghii, Glochidion velutinum, Chrysopogon aciculatus, Plantago major, Myriactis nepalensis, Dryopteris chrysocoma, Scutellaria discolor, Fraxinus floribundus, Marchantia sp., Cyrtococcum sp., Hydrocotyle nepalensis, Digitaria sp., Buddleja asiatica, Lycopodium clavatum, Viola serpens, Lipocarpha chinensis, Laggera alata, Eragrostis unioloides, Agave americana, Pennisetum clandestinum, Zornia gibbosa, Maesa macrophylla, Erianthus rufipilus, Prunus cerasoides, Cynodon dactylon, Desmodium heterocarpon, Impatiens racemosa, Cassia mimosoides, Borreria stricta, Equisetum diffusum, Oplismenus compositus, Juncus prismatocarpus, Crotalaria sessiliflora, Biophytum sensitivum, Prunella vulgaris, Tetrastigma serrulatum, Eriocaulon nepalense

Veröff.Geobot.Inst.ETH,Stiftung Rübel,Zürich, 93 (1987)
R. SCHAFFNER: Vegetation of stabilizing and eroding slopes in eastern Nepal.

Table 4.3. Plant composition and frequency, group 3, last survey (Oct. 1985) (for legend see Table 4.1)

Tab. 4.3. Zusammensetzung und Frequenz der Pflanzenarten auf den Untersuchungsflächen der Gruppe 3, letzte Aufnahme (Okt. 1985) (Legende siehe Tab. 4.1)

PLANT COMMUNITY	TRANSECT NO	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	1	1	1	2	1	2	2	1	1	1	1	1
		6	8	7	4	6	7	9	7	1	1	1	1	1	2	2	2	3	2	5	5	4	6	7	6	5	5	7	1	1	2	2	2	3	7	2	6	1	1	7	5	2	2	3
	SECTION NO	2	1	5	2	3	2	1	6	6	4	3	5	7	3	5	4	3	3	3	4	1	1	4	4	2	5	7	2	8	2	6	4	4	1	1	5	1	9	8	6	1	5	5
	SECTION SYMBOL	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△	△	△	△	△	△	△	△	□	□	□	□	□	□	□	□	□	□
	NO. SPECIES																																											
general slide community dry, young, poor soil, high pH	54 CENTELLA ASIATICA	+	2		+	1																																			5			
	219 MICROMERIA BIFLORA	2	3				5																												5									
	320 SETARIA PALLIDE-FUSCA	2	3		1	1															+																							
	342 SWERTIA SP.	2	2	1	+								1				2				1																							
	163 HEMARTHRIA COMPRESSA	1	1		1																1																				5			
	248 PASPALUM SCROBICULATUM	2	+		1																														1									
	17 ARTHRAXON LANCIFOLIUS	2	+		+		3								1							3													1									
	38 BRACHIARIA VILLOSA	3	5	2	1			1													+	3												2	3									
	93 DIGITARIA SP.	2	4	1	+			3														3																						
	333 SONCHUS ASPER	1	1	1		3	3																			5																		
	76 CYNOGLOSSUM SP.	3	4	1		1															+		5	5																				
	253 PHYLLANTHUS PARVIFOLIUS	2		2				3															8	9																				
	177 IMPERATA CYLINDRICA	6	2	6	1			7											1		+		8	9											1						4			
	183 ISODON COETSA	7	7	5		6	6	1													4		9	5	4			2							5					4				
	262 POGONATHERUM CRINITUM/PANICEUM	4	4	5	+	4	9	8										5	1				9	7		6		5							9					2				
	9 ANAPHALIS CONTORTA	6	5	5	3		7	2				1						5	3	1	+	5		6		6		7							6									
	118 ERIANTHUS RUFIPILUS		1		6			2											1	2	5																							
	16 ARTEMISIA VULGARIS	1	4	5		3														7	8					7	7														6			
	302 SACCIOLEPIS INDICA		1		2		5											4	1			6																				5		
	108 ELSHOLTZIA BLANDA		2		+	1	3															5						4																
	123 EULALIA MOLLIS	5	+	5	+	3	9	8	7													3					5	7							7									
	263 POLYGALA TRIPHYLLA		1	1			5	5																											5									
	359 VERONICA CINEREA/CONYZA JAPONICA		4	1	+		5	1	3																										1					2				
general slide community (→ transition - anchor) wet, older, more developed, richer soil, low pH	260 PLANTAGO MAJOR		+					1			3	3	1	5																									4					
	101 DRYMARIA DIANDRA		+								7	7	4	3	4		2				1									5	5							5	2					
	94 DIGITARIA ASCENDENS										5	3									2									5														
	83 DENNSTAEDTIA APPENDICULATA		1	2							5	4	5							3	2																				4			
	10 ANAPHALIS MARGARITACEA										5	1			4				1												5					5								
	273 POGONATUM JUNGHUHNIANUM				9				7	7			1		5	7	2	7	7			6						2		9		6		4								6	2	
	267 POLYGONUM UNCINATUM											3	4			5	2										4			5		6				3		5	2					
	11 ANAPHALIS TRIPLINERVIS											1			4	4	3			1							4								1	3								
	4 AGROSTIS PILOSULA		1							5					5	4	6		1	1	2					5	2	2								5								
	227 MYRIACTIS NEPALENSIS		+											3	2	5	6		1		1					4	5	3								3				2		3		
	176 IMPATIENS RACEMOSA/SERRATA											4	1			4	4										2												2					
	23 ASTILBE RIVULARIS											5	1				2				1								4															
	107 ELLISIOPHYLLUM PINNATUM											5	3	7															5									7	8					
	220 MICROSTEGIUM CILIATUM					6						7	4	3	3		3	2		6					6	6	8		8									9	4	2	7			
	169 HYDROCOTYLE NEPALENSIS/PODANTHA					2						5	7	6			4			2	5					6	7	6	6									4	2	5	7			
	210 LYONIA OVALIFOLIA				+								1		3	6	5	6	7		+							4			5		5	4								3	7	
	145 GAULTHERIA FRAGRANTISSIMA				3										1	5	2	7	7													5	6	5		5					4	7	4	
	334 GOLLANIA SP.									5			5	9			5		2	3	3					7	5		5	5	7					7		2	7	2		7	7	2
	347 RHODOBRYUM GIGANTEUM											2		3			2				1							2	5	6						3			2	7	2	5	4	5
	300 PTYCHANTHUS STRIATUS											1	1	9			5		1	1	5	3				7	2	6				9		7					7	7	2	9	8	9
anchor community	231 NEILLIA THYRSIFLORA																	1	2	1	5						5						7	7							8	3	6	7
	289 RANDIA TETRASPERMA																	1	1																						2	5	7	7
	295 ROSCOEA PURPUREA																	1	4												6			5	1	3						5	7	5
	340 STROBILANTHES SP.																	1			+											9		3								3	5	6
	130 EURYA JAPONICA																	1	2														4	3								8	7	
	209 LYCOPODIUM CLAVATUM																	2	6														9	8									9	8
	129 EURYA CERASIFOLIA																		2								5							5			6				5			8
	362 VIBURNUM STELLATUM																		1									5						4						4	2		7	8
	296 RUBIA CHARAEFOLIA					2	3												1		5				6		4	2							3		5	2					5	2
	283 PYRACANTHA CRENULATA					2	3												1	1	2						5	2						2						2	8	3		
	281 PTERIDIUM AQUILINUM																				+						5	7									4			7	5	3		
	103 DRYOPTERIS LEPIDOPODA																				+							5	5										5				2	
	27 ATHYRIUM SP.																																	2								5	6	6
	237 OPLISMENUS COMPOSITUS																																	4			4			4			7	7
	58 CHLOROPHYTUM NEPALENSE																																				2			2			4	5
	179 INDIGOFERA CYLINDRICA																																	2									5	2
	252 PHYLLANTHUS FLUEGGEIFORMIS						3													1															2				5			3		2
	230 MYRSINE SEMISERRATA																																5									5	7	4
	208 LUCULIA GRATISSIMA							1																											3						5		2	
	337 STELLARIA PATENS												1	3																						3		2	2		2			
	134 SPHENOMERIS CHINENSIS						3																					2						2	2					6				
	243 OXALIS CORNICULATA																				+																		2	5	2			
	361 VIBURNUM ERUBESCENS												1																									5	2					
	348 TETRASTIGMA SERRULATUM																												4								2	2	6					
basic species group	364 VIOLA SERPENS		+	1									2									3				5		2	4									5		4	2		4	
	49 CAREX DALTONII/LONGIPES	+	+					1					2				3				+							2				8	4	3		3			4		2	5		6
	48 CAREX CRUCIATA	+				2	3					3	2		1		3				+					5			6			9	6	5	5	5		4		5	5	5	8	6
	144 GALIUM SP.		3	3		1		1	3				3				5			1	3				5	9	5	6							1		4		5	7	6			2
	318 SELAGINELLA SP.	+	+			1	5	1	3	5		5	5	7	1	4	5		1	1	2	3		5		6	7	8	5	6	6	7		5	5	5			7	8	9		7	5
	126 EUPATORIUM ADENOPHORUM	9	9	7	7	9	5	5		7	5	8	7		8	9	9	8	7	9	8	9	9	7	8		6	8	7		9	9	7	6	6	8	8	7		9	8	9	7	6
	305 POGONATUM SEMINUDUM	7	7	7	5	7	8	3	6	9	3	7	7	3	9	8	9	9	7	8	7			6		5		7	4	9	6	9	6	3	5	3				2		5		
	6 ALNUS NEPALENSIS (partly cult.)	6	6	1	5	9	9			9		9	7	5	9	8	9	9	8	7	9	9			9	7	8		4		9	5		4	8	9	9							
	221 MICROSTEGIUM NUDUM	1	+	2	2					5	5	5	8	7	6	6	5	2	5	7	9					9	8	5	6	8	5	6	5	7		6			9		8	5		2
	249 MARCHANTIA SP.	5	6	4		3	7	4	7			6	1							7	7			5		9	6	6	9						3			4			5			
	214 DICRANELLA SP.	5	4	2	6	1		7	5			1	1		1	6		3	6	1	2					5		6				6			2									
	22 ARUNDINELLA NEPALENSIS	2	3		+	2	6	7	3									5	4		+	6		5			2	6							7						2	7	4	
	116 ERAGROSTIS PAPPOSA/NIGRA	5	4	5	3	5						1		8					2	5	3	7			5		5	5		5	6			2			2		2	2	5	3		
	147 GENTIANA CAPITATA	1	2	1			2	5				4	1	3			2			1											8			4	1					2		3		
	298 RUBUS ELLIPTICUS	2	2		2	5	3					7	4						1		1	3							8						4	5	4	8						
	30 BERBERIS ARISTATA/ASIATICA	+	2	2		1		5								4				1				6			5							3	6				2	2				
	173 HYPERICUM URALUM		+	1		1	3		3			6	5	3	4	5	6	1	2	4	3					6		6	7		9	5	5	6	2	5		2		5	2	3		5
	55 CHAMBAINIA CUSPIDATA	+								8	7	8	9		5	8	5			1	5				6	5	2	2	8	9	9	7		2		9		9	9	2	4			2
	292 RHODODENDRON ARBOREUM				+					8		1			5	9	5	5	3												5	6		2	5	5								
	184 ISODON STRIATUS					1	3				3		1		2	5	6		2	5	5					6	6				5	5		4		3			2		5	5	4	2
	339 STROBILANTHES ATROPURPUREUS	+				1	3	1	3																4			7							5		9			9				
	156 GONOSTEGIA HIRTA	1						1													+							4							4		2			7				
unspecific or rare species	280 PRUNUS CERASOIDES	+																			+																		2					
	324 SHUTERIA INVOLUCRATA	3						2																											1									
	171 HYPERICUM JAPONICUM	+	+														2																											
	70 CROTALARIA ALBIDA	1						5																											5									
	43 CALAMINTHE UMBROSUM	+	+											7							4					6	6												7		7			
	68 CONYZA STRICTA		2																					5											2									
	353 TRIPOGON FILIFORMIS		+					5																											1									
	241 OSBECKIA STELLATA		+															2	1														4	5									5	2
	46 CAPILLIPEDUM ASSIMILE		1	1														1										2												6		5		
	223 MISCANTHUS NEPALENSIS				4													5																3										
	41 BUPLEURUM SP.					2		1							1																													
	189 CAMPYLOPUS SP.							4							3		2		1																2							3		
	172 HYPERICUM NEPALENSE														1																6					3								
	164 HEMIPHRAGMA HETEROPHYLLUM												2						3											6														
	82 DAPHNIPHYLLUM HIMALAYENSE															8																9							7					
	152 GLEICHENIA GIGANTEA																	5	5								7							6										
	90 DICRANOPTERIS LINEARIS																	3	1																							8		
	312 SCHIMA WALLICHII				1														1														4									6		5
	168 HOUTTUYNIA CORDATA																				5						7														7			
	247 CYKTOCOCCUM SP.																					3												3									2	5
	285 QUERCUS FENESTRA																											5						3										
subgroup, specific for plot no 14	256 PILEA CORDIFOLIA										5		2																7									8						
	159 ANTHOCEROS SP.											2									+								4															
	205 LITSEA CUBEBA											1	2																	5														
	67 COMMELINA PALUDOSA											1																			5							4						
	141 FRAGARIA SP.											2		3																									5					
	5 AJUGA LOBATA												3	5																6									6					
	SECTION GROUPS	slide group																				transition group													anchor group									
	CHARACTERISTICS OF SECTION SUBGROUPS	dry aspect SW pH > 6.6 poor soil Eulalia Polygala Pogonatherum								wet aspect N pH < 6.7 some humus Drymaria Microsteg. Impatiens Hydrocotyle							poorer soil					dry asp.SW pH>6.6 poor soil				wet aspect N pH < 6.7 some humus									grassland shrubland overexpl.forest Daphniphyllum-forest Eurya Neillia Randia Roscoea									

Species only found in one or two sections:

Anchor: Geranium nepalense, Elsholtzia flava, Populus sp. (Sp.no 274), Polystichum squarrosum, Symplocos sp., Carex nubigena, Calypogeia sp., Pratia nummularia, Melothria heterophylla, Agapetes serpens, Microstegium vimineum, Smilax menispermoidea, Rubus acuminatus, Fimbristylis dichotoma, Labiatae 1, Smilax lancifolius, Osbeckia nepalensis, Hedera nepalensis, Rhus javanica, Sporobolus fertilis, Zanthoxylum acanthopodium, Leucosceptrum canum, Desmodium confertum, Cyperus rotundus, Eriobothrya dubia, Eulalia sp., Polypodium lachnopus, Bulbostylis capillaris, Valeriana hardwickii, Graniotome versicolor, Polygonum molle

Transition: Thelypteris sp., Symplocos sp., Microstegium vimineum, Sambucus adnata (Sp.no 304), Quercus fenestra, Arisaema costatum, Dichroa febrifuga, Ficus nemoralis, Fern sp., Polygonum nepalensis, Cheilanthes farinosa, Eurya acuminata, Kyllinga brevifolia, Polygonum molle

Slide: Carex atrata (Sp.no 47), Fimbristylis dichotoma, Sporobolus fertilis, Desmodium confertum, Bothriochloa intermedia, Melasma arvense, Eriophorum comosum, Boenninghausenia albiflora, Borreria latifolia, Buddleja asiatica, Erigeron floribundus, Scrophulariaceae?, Athyrium atkinsoni, Flemingia strobilifera, Cheilanthes farinosa, Oxyspora paniculata, Engelhardtia spicata, Eyria acuminata, Eulalia sp., Eragrostis atrovirens, Campanula coloratum, Cynodon dactylon, Eriobotrya dubia, Ledanthus peduncularis, Mazus japonicus (Sp.no 215), Pteris wallichiana, Hypericum cordifolium, Polygonum spaerocephalum, Crassocephalus crepidioides, Orchidaceae sp., Eulalia sp., Shuteria ferruginea, Athyrium nigripes, Elsholtzia pilosa

Table 4.4. Plant composition and frequency, group 4, last survey, (Oct. 1985) (for legend see Table 4.1)

Tab. 4.4. Zusammensetzung und Frequenz der Pflanzenarten auf den Untersuchungsflächen der Gruppe 4, letzte Aufnahme (Okt. 1985) (Legende siehe Tab. 4.1)

PLANT COMMUNITY	TRANSECT NO	3	2	3	3	2	2	3	3	3	2	2	2	2	2	3	3	2	2	2	2	3	3	3	3	2	2	3	3	2	2	2	2	3	3	3	2	3	3
		0	5	1	0	5	9	0	0	2	6	7	3	3	8	3	2	9	3	6	6	1	1	3	3	5	5	0	0	9	4	8	4	3	1	1	5	0	0
	SECTION NO	4	1	4	6	2	1	3	5	1	4	1	4	3	3	3	2	2	2	5	2	5	2	2	4	3	4	2	7	3	1	1	3	5	1	6	5	1	8
	SECTION SYMBOL	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△	△	△	△	△	△	△	△	□	□	□	□	□	□	□	□	□	□
	NO. SPECIES																																						
slide community poorer soil	186 JUNCUS ELEGANS					+	1							2																									
	41 BUPLEURUM SP.						1	2	2				1										2																
	246 PAROCHETUS COMMUNIS										1	+				1																							
	145 GAULTHERIA FRAGRANTISSIMA							2	1	2	+										3																		
	78 DESMODIUM MICROPHYLLUM					+		5	2						+						2					2													
	210 LYONIA OVALIFOLIA					+	1	4			3		5	3	+	1					5	5	4	7															
	172 HYPERICUM NEPALENSE				5					1		+			1						2	2	6																
	227 MYRIACTIS NEPALENSIS						1	4				+		3	1				5				2	1													5		
	182 ISACHNE ALBENS												3	2					8																				
	320 SETARIA PALLIDE-FUSCA											1			+	1				2																			
	94 DIGITARIA ASCENDENS						1			1	2	2		4					5				4		4						5								
	126 EUPATORIUM ADENOPHORUM						1		4		+	1		2	1	6	8			2	3			8	7	2					4			9					
	299 RUBUS NEPALENSIS/FOCKEANUS						2			2	1	1	7	8	+				9							2	6					7					9		
slide community wet, richer soil	337 STELLARIA PATENS			2										3	+	2				2			5	1												3			
	215 MAZUS JAPONICUS													2	+	5							4																
	260 PLANTAGO MAJOR													4	+	3			7					1	2														
	169 HYDROCOTYLE NEPALENSIS/PODANTHA												6	5		1									4														
	50 CAREX NUBIGENA											1			3								2		2														
	43 CALAMINTHE UMBROSUM										+			5	1	7									5							3				3			
slide-transition community wet soil	55 CHAMBAINIA CUSPIDATA										1	3	9	8	2	8			9					9	6						4	5	7	9					
	318 SELAGINELLA SP.					+					1	1	5	2		7				6		6	2	9	7	3	8		5	8	7	3	8	5	7	9			
	101 DRYMARIA DIANDRA									1		+		5	1	9						2		5	8						5	5		7	6			4	
	342 SWERTIA SP.					1					+		2	2	1	1			7			4		5	2					5	5		5	6				4	
	74 CYANOTIS VAGA/AXILLARIS									1	+		2	3	1	2						5	2			2	5			6	6				6	8			
	141 FRAGARIA SP.									3			4	4			9					5	7			2	7						5		4	9	8		
	173 HYPERICUM URALUM			2					4	6	+				1	5	7						2	4							7							4	
	159 ANTHOCEROS SP.								1					2		1			7				4	1						1					5			4	
	281 PTERIDIUM AQUILINUM										1	3				1					3					2	7			4									
	194 KYLLINGA BREVIFOLIA													1					7			7			3		5									5			
	40 BULBOSTYLIS CAPILLARIS					1	1				1		1	1	+				5				2			5				2	2	3			4				
	221 MICROSTEGIUM NUDUM											+				9					5			8	6									5					
	156 GONOSTEGIA HIRTA										5	3				4				7					7	2	6			5		8							
	189 CAMPYLOPUS SP.					6	2				1	+			1			6			5					9	7			5									
anchor community	149 GERANIUM NEPALENSE			2			1								+	2																	4		5	5			
	296 RUBIA CHARAEFOLIA										2				+									1								6				3			
	67 COMMELINA PALUDOSA							2								1	8							6	4						7	5		7					
	267 POLYGONUM UNCINATUM															6								4	7						2			5			6		
	175 IMPATIENS DISCOLOR																						4						5							3	5		
	198 LEDANTHUS PEDUNCULARIS													1																			4					5	
	300 PTYCHANTHUS STRIATUS													1										1				5					7				6	4	
	31 BERBERIS WALLICHIANA																									5					7								7
	364 VIOLA SERPENS							4	1	2						1											5		5		5	3	4		4	7	6		5
	239 ORYZOPSIS LATERALIS							4		4					2													9			9	7	4				9	9	7
	295 ROSCOEA PURPUREA				5			5	2													2						9	7							7		7	6
	356 VALERIANA HARDWICKII/JATAMANSI			2												2						2						6			6					3	5	4	5
	334 ECTROPOTHECINUS SP.													1													5	5			2		6		7		6	7	6
	288 QUERCUS SEMECARPIFOLIA																											9	6			3		9		8		7	7
	330 SMILAX MENISPERMOIDEA/ASPERA																											6	5										6
	179 INDIGOFERA CYLINDRICA				4																	2							5								5		5
	347 RHODOBRYUM GIGANTEUM				4				1																											4		6	7
basic species group	273 POGONATUM JUNGHUHNIANUM/MICROSTOMUM	5	7	7	8	8	9	8	8	7	7	8	7	6	8	4		9	5	5	9	5	8	6		8		8	5	5	5	5			6			9	5
	9 ANAPHALIS CONTORTA	3	5	6		6	7	6	6	6	7	8	9	7	8	4		9		8	9	7	4	4	4	8	7			8	8	7	6		7	4			5
	176 IMPATIENS RACEMOSA/SERRATA	7		5	7			7	8	3	1	2	5	5	5					2		5	5					7	7		4	3			5	4	5	5	5
	214 DICRANELLA SP.	2	2	2	4		5	5	5	1	2	2	2	2	2			6					4	5			5	7		5	5				7				7
	266 POLYGONUM NEPALENSIS	4		4	4	+		4	3	5	4	4	3	2	1	2		5		2			4								6				8	5			
	305 POGONATUM SEMINUDUM	1	4		7	2	6	6	1	5	3	1	6	6	7	1					5		5	1		2				5	4				6	5		5	
	164 HEMIPHRAGMA HETEROPHYLLUM		7	9		5	4	7	8	1	6	5	8	5	6	5		6		7	3	7	7	7	4	6	7		6	5	7		5		7	8	5		7
	110 ELSHOLTZIA PILOSA		4	4	5	3	5	5	2	5	4	5	6	6	5	5		5	5		3	6	6	5		2			5	6		3			7	4			
	4 AGROSTIS PILOSULA		5	2		4	5	2	3	2	5	5	7	5	5	4		8	7	7	6		2				7	5	5	8	5				5	4			5
	276 POTENTILLA FULGENS		4	5		2	3			1	5	3	3	1	3					4		6	5	1		5	9		6	9	2				8		5		
	116 ERAGROSTIS PAPPOSA/NIGRA		5	2		5	6			1	6	5	6	5	6	7		7	7	4			7	6	5	3	5			7	5	5	4						
	17 ARTHRAXON LANCIFOLIUS		5			3	5	2		1	5	6	1		2			9		5	2	5	4			5			5	8	5		4		8	7			5
	47 CAREX ATRATA			2	5	1	5	5			7	7	5	3	5	1		4	7	8	4	7	6	7		2			6	7		5	6		8	3			6
	147 GENTIANA CAPITATA			2		1	1	2			1		5	2	1						2		2	5			7	7	5	5	2		7	4		5	5		6
	21 ARUNDINELLA HOOKERI			5		2	1			1	7	6			+			7		7	6	6	4			9	9			9					6	3	5		
	48 CAREX CRUCIATA			6	4			7	6	1		1	2	2	1		7			7		4	6		2		5	6	7	6	9	8	6	5		7	6	7	6
	11 ANAPHALIS TRIPLINERVIS			5	7		1	6	5	1			1		+							7	6			2		8	6				6			7		7	7
	49 CAREX DALTONII/LONGIPES			5	5			4				+	2	2	1						2	2	4		5	5				2	4		5	5		7			7
	340 STROBILANTHES SP.			5				4	1				5	2									2					6	7		7		5	8		3		5	
	353 TRIPOGON FILIFORMIS		2			3	1				1	+			+					5	2					9	6			7	4				5				
	144 GALIUM SP.					+			2	2	2	1	1	6	2	7				5	4	2	5	7	5		5					8	4	4		7			
unspecific or rare species	38 BRACHIARIA VILLOSA														+	1								4															
	243 OXALIS CORNICULATA															5								5	2														
	269 POLYGONUM SPHAEROCEPHALUM																		5								5			4									
	302 SACCIOLEPIS INDICA											+															5			2									
	14 ARISAEMA COSTATUM						1								+								2							1	4								
	143 GALINSOGA PARVIFLORA/CILIATA											+			+	1							2									3							
	132 FERN SP.											1											2	1	2							3							
	6 ALNUS NEPALENSIS (cult.)						2			6					5	7																9							
	358 VANDELLIA NUMMULARIFOLIA					+						+			+	1							2		2					1					5				
	104 EDGEWORTHIA GARDNERI																				2	7														6			
	292 RHODODENDRON ARBOREUM					+		4													6			1								7		5					
	319 SENECIO DENSIFLORUS									1						6									8									4					
	249 MARCHANTIA SP.															1												5										7	
	254 PIERIS FORMOSA				7		1		2								9				3																		6
	SECTION GROUPS	slide group															transition group													anchor group									
	CHARACTERISTICS OF SECTION SUBGROUPS	un-specific on poor soil					typical on poor soil Gaulth. Lyonia				more covered on richer soil, wet Chambainia Drymaria Selaginella						unspecific, poor ground		in grassland or shrubland richer soil									in Quercus-forest, rich soil		grassland-shrubland-Quercus-forest rich soil, humus overexploited Quercus semecarp. Oryzopsis lateralis Ectropothecinus									

Species only found in one or two sections:

Anchor: Smithia ciliata, Scrophulariaceae?, Dryopteris lepidopoda, Athyrium atkinsoni, Lycopodium clavatum, Arundinaria aristata, Chlorophytum nepalense, Shuteria ferruginea, Didymocarpus sp., Anemone rivularis (Spec.no 12), Gerbera maxima, Orchidaceae sp., Digitaria cruciata, Begonia sp., Zingiberaceae sp., Melothria heterophylla, Viburnum erubescens, Ranunculus hirtellus, Pteris wallichiana, Rhus succedanea

Transition: Smithia ciliata, Taraxacum sp., Pyracantha crenulata, Viola hookeri, Eulalia mollis, Paspalum scrobiculatum, Phyllanthus flueggeiformis, Arundinella nepalensis, Anaphalis busua, Shuteria ferruginea, Centella asiatica, Epilobium wallichianum, Leguminosae?, Orchidaceae sp., Begonia sp., Rubus ellipticus (Spec.no 298), Rhus succedanea

Slide: Juncus prismatocarpus, Hypericum japonicum, Polygonum capitatum, Equisetum diffusum, Cynodon dactylon, Boenninghausenia albiflora, Berberis aristata, Cyperus globosus, Murdannia nudiflorum, Sporobolus piliferus, Pennisetum clandestinum, Erianthus rufipilus, Cyperus sanguinolentus, Anaphalis margaritacea, Prunella vulgaris, Dennstaedtia appendiculata, Scirpus sedateus, Epilobium wallichianum, Leguminosae?, Fimbristylis dichotoma, Pteris wallichiana, Rubus ellipticus

Table 4.5. Stable areas: Plant composition and abundance
Tab. 4.5. Intakte Gebiete: Zusammensetzung und Häufigkeit der Pflanzenarten

+ = scarcely or only 1% of the area
1 = covering less than 5% of the area
2 = covering 5 to 25% of the area
3 = covering 25 to 50% of the area
4 = covering 50 to 75% of the area
5 = covering 75 to 100% of the area

D = Daphniphyllum-forest
G = Imperata-grassland
P = Pinus roxburghii-forest
Q = Quercus semecarpifolia-forest
S = Eupatorium-shrubland
SCH = Schima wallichii-forest with Eurya acuminata

STABLE AREA NO		9	11	3	10	7	6	2	1	8	5	4	12a	12b	12c	12d	13
TYPE OF VEGETATION		G	G	S	S	S	S	P	P	SCH	SCH	SCH	D	D	D	D	Q
TREE LAYER INCL. REGENERATION IN SHRUB LAYER (S) AND HERB LAYER (H)																	
DAPHNIPHYLLUM HIMALAYENSE													2	2	4	4	
DAPHNIPHYLLUM HIMALAYENSE	S													2	2		
DAPHNIPHYLLUM HIMALAYENSE	H													2	1	1	
SYMPLOCOS CRATAEGOIDES													3	3	2	2	
SYMPLOCOS CRATAEGOIDES	S										+		3	2	2	3	
SYMPLOCOS CRATAEGOIDES ≥ 1	H					+				+	+	1	2	1	2	2	
ALNUS NEPALENSIS													2	2	+		
RHUS SUCCEDANEA													+	+	+		
EURYA JAPONICA	S												+	1			
EURYA JAPONICA	H												1	1	1	+	
CRYPSINUS EBENIPES														1	1		
SMILACACEAE													+	+			
VIBURNUM STELLATUM													1	1			
VIBURNUM ERUBESCENS													1	1	+	1	
HEDERA NEPALENSIS													+			+	
HEDERA NEPALENSIS	S														1	1	
HEDERA NEPALENSIS	H												+		2	2	
EURYA CERASIFOLIA	S														+	1	
EURYA CERASIFOLIA	H															2	
EURYA CERASIFOLIA															+	2	
LEUCOSCEPTRUM CANUM															+	1	
LEUCOSCEPTRUM CANUM	S														+	1	
LEUCOSCEPTRUM CANUM	H														+	1	
MYRSINE SEMISERRATA	H														+	+	
HERMINIUM LANCEUM															1	+	
SMILAX MENISPERMOIDEA															+		+
ARAIOSTEGIA SP.															+	1	+
LEPISORUS BICOLOR														1	1		+
QUERCUS SEMECARPIFOLIA															1		3
RHODODENDRON ARBOREUM											2	3	2				2
RHODODENDRON ARBOREUM	S											2					2
RHODODENDRON ARBOREUM	H				+							1			+		
LYONIA OVALIFOLIA										+	1	1	3	3	2	1	+
LYONIA OVALIFOLIA	S									1	1	1	2	1		2	
LYONIA OVALIFOLIA	H		+		1					2	+	1		1	+		
BERBERIS ARISTATA/ASIATICA												1	1				
PYRUS PASHIA	S				+		2										
PYRUS PASHIA	H				+							1					
MYRSINE CAPITELLATA	S						2				2	2					
MYRSINE CAPITELLATA	H					1	1				+	2					
EURYA ACUMINATA	H						+			2	1	2					
ENGELHARDTIA SPICATA												3					
ENGELHARDTIA SPICATA	H								+		1						
CASTANOPSIS TRIBULOIDES	S											2					
CASTANOPSIS TRIBULOIDES	H								+	+	+	1					
QUERCUS LANATA	H										+	+					
QUERCUS GLAUCA	H											2					
RHUS JAVANICA											+	1					
RHUS JAVANICA	S										1	2					
RHUS JAVANICA	H										1	1					
ERIOBOTRYA DUBIA	S										+	1					
ERIOBOTRYA DUBIA	H										+	1					
EURYA ACUMINATA											1	1					
PAVETTA TOMENTOSA	S										+	1					
PAVETTA TOMENTOSA	H										1	+					
SCHIMA WALLICHII									+	3	1	2					
SCHIMA WALLICHII	S			2		+	+		1	2	2						
SCHIMA WALLICHII	H							+	1	2	+	1					
PREMNA SP.	H						+	+	+								
PINUS ROXBURGHII								3	2								
PINUS ROXBURGHII	S								1								
PINUS ROXBURGHII	H							+	1								
SHRUB LAYER INCL. REGENERATION IN HERB LAYER (H)																	
VIBURNUM ERUBESCENS													2	2	1	2	
VIBURNUM ERUBESCENS	H												1	1	1		
DAPHNE BHOLUA													1	2	1	1	
DAPHNE BHOLUA	H									+			2	1	2	2	
HYPERICUM URALUM										+			+	1	+	2	
HYPERICUM URALUM	H													1	1	1	1
THESPESIA SP?													1	+	+	+	
THESPESIA SP?	H												+	+		+	
RUBUS PANICULATUS	S												+				
RUBUS PANICULATUS	H												+	+	1		
VIBURNUM STELLATUM													1	1	1		
VIBURNUM STELLATUM	H												1		1	+	
SARCOCOCCA PRUNIFORMIS											+			1	+		
SARCOCOCCA PRUNIFORMIS	H						+				+		2	2	2	1	
POLYGONUM MOLLE													+	1		1	
POLYGONUM MOLLE	H												1	1		1	
SENECIO TRILIGULATO														+	2	1	
SENECIO TRILIGULATO	H														2	1	
ELSHOLTZIA FRUTICOSA														1		+	
PILEA CORDIFOLIA															+	1	
PTERIS WALLICHIANA															+	1	
WICKSTROEMIA CANESCENS	H												1	+			
CRYPSINUS EBENIPES													+	+			
LEPISORUS BICOLOR													1			+	
INDIGOFERA CYLINDRICA	H													1			+
VIBURNUM CORIACEUM											+	+					
LABIATAE 1											1	1					
DICRANOPTERIS LINEARIS										+		1					
DICRANOPTERIS LINEARIS	H									4	2	3					
DESMODIUM CONFERTUM	H								1		+						
COLQUHOUNIA COCCINEA	H								+			1					
GLOCHIDION VELUTINUM	H								+		+	1					
MELASTOMA NORMALE							+			+		1					
MELASTOMA NORMALE	H							+	+	1		1					
SMILAX ASPERA							+					1					
SMILAX ASPERA	H						+					1					
INULA CAPPA	H				+		+		1	+	+	1					
INDIGOFERA DOSNA	H			+		+		1	1		+						
HYPERICUM CORDIFOLIUM				1		+			1	+							
HYPERICUM CORDIFOLIUM	H			1		1		+	1	2	1						
PHYLLANTHUS PARVIFOLIUS				+		2	2			2	1	2					
PHYLLANTHUS PARVIFOLIUS	H		1	1		1	3	1	1	3	2	2					
OSBECKIA STELLATA					+		1			+	1						
OSBECKIA STELLATA	H		1		1	1	1			2	1						
RANDIA TETRASPERMA						+										+	
RANDIA TETRASPERMA	H		+				+			2				+		2	
PHYLLANTHUS FLUEGGEIFORMIS	H		1		+								1			+	
BERBERIS ARISTATA/ASIATICA	H		1		1	1	2		+	1	1	1	1	1	1		
GAULTHERIA FRAGRANTISSIMA	H				2					1	1	1		+	+	+	+
PYRACANTHA CRENULATA				+			+										
RUBUS ELLIPTICUS						+	+										
HERB LAYER INCL. MOSS LAYER (M)																	
RUBIA CHARAEFOLIA												+	+	+	1	+	+
VALERIANA HARDWICKII												+	1	+	1	1	1
ATHYRIUM ATKINSONI												1			1	2	1
SMILAX MENISPERMOIDEA													1	+	1	1	+
STROBILANTHES SP.													2	2	2	2	2
HEMIPHRAGMA HETEROPHYLLUM													1	1		+	1
BEGONIA SP.															1	1	1
ARISAEMA COSTATUM										+			1	2	1		1
ELLISIOPHYLLUM PINNATUM													+	1	2	2	
CHAMBAINIA CUSPIDATA													+	1	2	3	
ANAPHALIS MARGARITACEA													+	+		+	
EUONYMUS ECHINATUS													+	+	1	1	
AGAPETES SERPENS													+		1		
SHUTERIA FERRUGINEA														+	2		
RANUNCULUS HIRTELLUS													+	+			
IMPATIENS DISCOLOR													1	1	1		
FRAGARIA SP.													1		+		
ATHYRIUM SP.							+						1	2	2	2	
PTERIS WALLICHIANA															+	1	
CHIRITA URTICIFOLIA															1	2	
HOLBOELLIA LATIFOLIA														+		1	
GLOBA SP.												+		+	1	1	
CALYPOGEIA SP.	M														2	1	
ANTHOCEROS SP.	M											1		+			
THUIDIUM SP.	M											2		1	1		
POLYSTICHUM SQUARROSUM										+				1	1	+	
LEPISORUS BICOLOR										+			1		+	+	
HERMINIUM LANCEUM									+	+		+					+
HYDROCOTYLE NEPALENSIS/PODANTHA									1					+	+	1	
MELOTHRIA HETEROPHYLLA									+			+	+				
PTERIDIUM AQUILINUM			+						2		1	+	2	1		+	
CAREX DALTONII/LONGIPES			+				+	1					+	1		+	
ARISAEMA ERUBESCENS							+	+	+			1	1	1			
ARTHRAXON QUARTINIANUS							1			1			+		1	2	
TAXITHELIUM SP? (HYPNOCEAE)	M				+		1					2	+		1	1	
RHODOBRYUM GIGANTEUM	M				+		+			+		1	1	+	1	1	
CHLOROPHYTUM NEPALENSE					+		+			+	+	1	1	1	+	1	
VITIS LANATA							+				+	+					
NEPHROLEPIS CORDIFOLIA							2					2					
JAMESONIELLA SP?	M											2					
MURDANNIA NUDIFLORUM							1	1	+								
KYLLINGA BREVIFOLIA					+	+	2	1		1						+	
DESMODIUM HETEROCARPON				+			+	2	+	1		1					
ERAGROSTIELLA BIFARIA				1		1		2			1						
PASPALUM SCROBICULATUM				1	+	+	1	2	+	+							
BRACHIARIA VILLOSA				1	+		1	2	+	+							
SIDA RHOMBIFOLIA				+					+	+							
SETARIA PALLIDE-FUSCA				1		+			1								
EUPHORBIA HIRTA				1		1	1		2								
DRYMARIA DIANDRA				2	+	1											
CAREX CRUCIATA					+					+	+	1	2	2	2	2	2
ANAPHALIS TRIPLINERVIS					+						+	+	+				1
GALIUM SP.					+				+	+						1	1
VIOLA SERPENS					+								1	1		1	1
ARTHRAXON LANCIFOLIUS			2	2	1	1	2		+	1	1						2
ANAPHALIS CONTORTA		+	2	+	+	+				2	+						2
EUPATORIUM ADENOPHORUM		+	1	+	3	2	4	1	2	2	2	1		1	2	2	
IMPERATA CYLINDRICA		3	3	1	1	+	2	2	+	2	+	1					
BULBOSTYLIS CAPILLARIS		1	1				+					+					
ARUNDINELLA NEPALENSIS			3	2	+	+	2		1	1	1	1					
POGONATHERUM CRINITUM/PANICEUM			1		2	2	+	1	3	2	1	2					
SACCIOLEPIS INDICA			2	+	+	+	1	1	+			+					
VANDELLIA NUMMULARIFOLIA			1	1	1	+		1				1					
CRASSOCEPHALUS CREPIDIOIDES			+	1							+	+					
CHEILANTHES FARINOSA			1			+	1	1	2		+	1					
GONOSTEGIA HIRTA			+	1	1	1	3		1	2	1	1					
ERAGROSTIS PAPPOSA/NIGRA			1					1			+						
CROTALARIA ALBIDA			2	+			+		+	+							
SCHIZACHYRIUM BREVIFOLIUM		2	2	+	+		2	2		1							
ERAGROSTIS ATROVIRENS		+	1	1			1			+							
VERNONIA CINEREA/CONYZA JAPONICA		+	1		+	+	+	1	+								
AGERATUM CONYCOIDES			1	+				1	+								
CROTALARIA HUMIFUSA		+	1				1		+								
BORRERIA STRICTA			2			+			1								
SPOROBOLUS PILIFERUS			2	1	1	+		2									
DESMODIUM MICROPHYLLUM		2	1				1	1									
FIMBRISTYLIS DICHOTOMA		+		1	+	+	2	1									
OXALIS CORNICULATA		1	1		+	+	1	1									
HYPERICUM JAPONICUM		1	2					1									
SMITHIA CILIATA		1	1				+	2									
ERIGERON FLORIBUNDUS/MULTICAULIS		+				+		+									
JUSTICIA PROCUMBENS								2									
PYRACANTHA CRENULATA		1	1	+	+	+	+										
CYANOTIS VAGA/AXILLARIS			1	1		+	1										
TARAXACUM SP.		+	+	+			+										
MICROMERIA BIFLORA		1	1	1	+	+											
POLYGONUM NEPALENSIS			+	+	1		+										+
ISODON STRIATUS			+		+		1			1		1	1	2	1	1	1
ROSCOEA PURPUREA		+	1		+		+				+		1			+	1
SELAGINELLA SP.			2	1	+					1	1		2	1	2	2	1
GENTIANA CAPITATA		+		+	+	+		+			+	+	1		+	1	1
PTYCHANTHUS STRIATUS	M				+		1				2	2	+	2	2	2	2
POGONATUM JUNGHUHNIANUM	M				+					2	2	+	2	1		1	2
POGONATUM SEMINUDUM	M			+	+	1	2			2	1	1	+	1			1
OREOWEISIA LATIFOLIA	M			+				2		2	1	2	2	1		1	1
MYRIACTIS NEPALENSIS					+								+			+	1
IMPATIENS RACEMOSA/SERRATA																	2
ELSHOLTZIA PILOSA										+							1
SWERTIA SP.		+														+	
GALINSOGA PARVIFOLIA/CILIATA						+										+	
OPLISMENUS COMPOSITUS/BURMANII										1				1			
LEUCOSTEGIA IMMERSA							+						+				
SHUTERIA INVOLUCRATA									+				+				
PHYLLANTHUS RETICULATUS												1	+				
MARCHANTIA SP.	M		1							1		1					
BIDENS PILOSA				+		+						+					
SMILAX LANCIFOLIA							+				+	1					
DIOSCOREA GLABRA							+					1					
CAPILLIPEDUM ASSIMILE										1		1					
CLEMATIS SP.									+			+					
TRIUMFETTA PILOSA									+			+					
HEDYOTIS SCANDENS												2					
SHUTERIA VESTITIA						+					+						
EULALIA SP.					+						1						
ZORNIA GIBBOSA		+									1						
CAMPYLOPUS SP.	M									2							
ATHYRIUM SP.										2							
STROBILANTHES ATROPURPUREUS										2							
THELYPTERIS SP.										2							
BIOPHYTUM SENSITIVUM									2								
HYPOXIS AUREA							+			+							
POLYGONUM CAPITATUM							+			+							
ELEPHANTOPUS SCABER								+	+								
LAGGERA ALATA								1	+								
SCUTELLARIA DISCOLOR							+	1									
TRIPOGON FILIFORMIS				1			+										
CENTELLA ASIATICA		1					3										
OLDENLANDIA CORYMBOSA						+	1										
ERAGROSTIS UNIOLOIDES				2		1											
FLEMINGIA STROBILIFERA			1		+												

Species found with abundance of + or 1 in only one area:

Tree layer:

Area 4 : Wendlandia coriacea, Rhus wallichii, Pyrus pashia, Phyllanthus emblica, Osyris arborea, Smilax aspera, Quercus glauca, Hedyotis scandens
Area 5 : Labiatae 1
Area 12a: Viburnum coriaceum, Rubus paniculatus
Area 12b: Vitis lanata, Rubia charaefolia, Polygonum molle, Melothria heterophylla, Clematis sp.
Area 12c: Tetrastigma serrulatum, Selaginella sp., Prunus nepalensis, Ilex dipyrena
Area 12d: Thespesia sp?, Shuteria ferruginea

Shrub layer:

Area 1 : Pinus roxburghii, Celastraceae?
Area 4 : Prunus cerasoides, Ficus nemoralis, Quercus glauca, Fraxinus floribundus, Osyris arborea, Euphorbiaceae?, Hypericum cordifolium, Hedyotis scandens, Smilax lancifolius, Capillipedum assimile
Area 5 : Rhus wallichii, Quercus lanata, Engelhardtia spicata
Area 6 : Flacourticaceae sp., Clematis sp., Arundinella nepalensis
Area 7 : Osbeckia nepalensis
Area 8 : Fraxinus floribundus
Area 12a: Wickstroemia canescens, Herminium lanceum
Area 12b: Ceropegia longifolia, Selaginella sp., Codonopsis viridis
Area 12c: Ilex dipyrena, Shuteria ferruginea, Agapetes serpens, Smilax menispermoidea, Melothria heterophylla, Achyranthes bidentata
Area 12d: Phyllanthus flueggeiformis, Tetrastigma serrulatum
Area 13 : Arundinaria aristata, Litsea sp.

Herb layer:

Area 1 : Borreria latifolia, Indigofera atropurpurea, Gerbera sp., Eriosema chinensis, Crotalaria sessiliflora, Barleria cristata, Triumfetta rhomboidea, Woodfordia fruticosa, Wrightia antidysenterica
Area 2 : Eulalia sp., Chrysopogon aciculatus
Area 3 : Digitaria ascendens, Bidens bipinnata
Area 4 : Schefflera venulosa, Crypsinus ebenipes, Clematis sp., Arthromeris himalayensis, Osyris arborea, Scrophulariaceae?, Euphorbiaceae?, fern sp., Labiatae 1, Orchidaceae sp., Vitis parviflora
Area 5 : Desmodium concinuum
Area 6 : Flacourticaceae sp., Dioscorea bulbifera, Ceropegia longifolia, small shrub, Polygala persicariaefolia
Area 7 : Polygonum sphaerocephalum, Digitaria cruciata
Area 8 : Prunus cerasoides, Ficus nemoralis
Area 9 : Spiranthes sinensis, Mazus japonicus, Bothriochloa intermedia, Cynodon dactylon
Area 10 : Sporobolus piliferus, Leguminosae sp.
Area 11 : Conyza stricta
Area 12a: Pimpinella diversifolia, Thelypteris multilineata, Lycopodium clavatum
Area 12b: Symplocos sp., Didymocarpus sp., Pratia nummularia, Polypodium argutum
Area 12c: Achyranthes bidentata, Boenninghausenia albiflora, Dichroa febrifuga, Elastostema obtusum, Microstegium vimineum, Polygonum uncinatum, Parochetus communis, Campylandra aurantica, Zanthoxylum sp., Gleichenia gigantea
Area 12d: Ilex dipyrena, Elsholtzia fruticosa, Codonopsis viridis, Dryopteris lepidopoda, Tetrastigma serrulatum, Scrophularia urticaefolia
Area 13 : Potentilla fulgens, Labiatae?, Juncus elegans, Dryopteris chrysocoma, Desmodium elegans, Campanula coloratum, Agrostis pilosula, Carex atrata, Arundinaria aristata

Moss layer:

Area 4 : Leucobryum sp., other moss spp.

Table 4.6. Change of plant frequency during the postmonsoon records (1983, 1984, 1985), group 1
Tab. 4.6. Entwicklung der Frequenzen der Pflanzenarten nach dem Monsun (1983, 1984, 1985) auf den Untersuchungsflächen der Gruppe 1

Season: 1 = 1983, 4 = 1984, 7 = 1985; section symbols as Table 4.1; for relevé group compare Fig. 4.34

RELEVÉ GROUP NO	1	1	1	1	2	2	2	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	6	6	5	6	6	7	7	7	7	7	7	7	7	7	7	7	7	8	8	8	9	9	10	10	10	10	10	10	10	10	10
TRANSECT NO	7	7	7	7	7	7	7	7	7	7	7	1	1	1	2	2	2	3	2	2	1	1	3	1	3	1	2	1	1	1	1	1	4	4	5	5	5	4	4	4	6	6	4	6	2	2	2	2	1	4	4	4	5	5	5	5	4	4
SECTION NO	4	4	4	5	3	3	3	2	1	2	2	2	2	2	2	2	2	1	3	3	3	4	1	3	1	3	3	4	4	5	5	5	3	3	1	1	1	3	4	4	1	1	4	1	4	4	4	1	1	2	2	2	2	2	2	3	5	1
SEASON	7	4	1	7	4	1	7	7	7	4	1	4	1	7	7	1	4	7	7	4	7	7	4	4	1	1	1	4	1	4	1	7	7	4	4	7	1	1	4	1	7	4	7	1	7	4	1	7	7	7	4	1	4	1	7	7	7	7
SECTION: SYMBOL	△	△	△	□	○	○	○	△	□	△	△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	○	○	○	○	○	○	○	○	○	○	○	○	△	△		□	□	○	○	○	○	○	○	□	□	□
NO SPECIES																																																										
253 PHYLLANTHUS PARVIFOLIUS							1								3	5		2			5	5	1	2	4	2	2	5		5	4	5	5	5	5	6	5	4	7	6	7	7	8	7				5	4	5	5	5	7	8	8	8	7	5
232 NEPHROLEPIS CORDIFOLIA															5	5	6	1		1	2		+				+						5	5	5	5	2		5	5	6	6	5	5	7	5	4	7	3	5	4	5	8	7	8	8	8	8
210 LYONIA OVALIFOLIA															5	3	3		2			7					+	5							5		5	1	5	3	2	2	5	1				5					7	7	7	7	7	5
305 POGONATUM SEMINUDUM					3	5	5			4		2			3	7	5	5	2	1	3	5	4		1	2	2						6	5	7	6	5	7	5	7	6	2	7	1	6			2	3	8	7	9	6	4	8	6	6	
138 FIMBRISTYLIS DICHOTOMA					1	2	2			4	4					5	3	3	+	2			2		5		4			6	4		6	6	7	6	5	6	5	4	6	7	6	6				2			2		2					2
177 IMPERATA CYLINDRICA						+	+		7			2		6	5	3	5	3	1	5			5	5	5	5				4			6	4	4	6	4	4	3	3	6	5	3	5				8	8				2	2		3	7	1
313 SCHIZACHYRIUM BREVIFOLIUM					2	1	5						2	2	5	5	3	6	5	5	7	6	7	7	7	7	4	3	5	5	4	8	5	6	6	7	5	6	7	7	6	6	7	6							6	5			2		5	1
156 GONOSTEGIA HIRTA					+	+	1		5				2		6	3	5	6	2	2	7	6	6	6	5	6	1	5	5	7	7	8	5	5	5	4	4	5	6	5	5	5	5	2	5			2	3	5	4	4	2	4		6	5	5
6 ALNUS NEPALENSIS					5	2	5					5	5	7	5	5	5	7	7	7	8	7	7	8	7	5	7	8	6																													
273 POGONAT JUNGHUHNIANUM					1	1						7	5			3	3	1	+	5	2	7	2	6	2	5	5	9	9				2		3	1	2	4	5	3	4	5	5	5			4											
214 CERATODON PURPUREUS					1							5	6	4			5	+	1	5	3		6	5	5	2	5	9	3	7	7		2	4	2		1		7	7		7	1	5		4	5						7	7	2			
258 PINUS ROXBURGHII	9	9	7	9	4	1	6		6																					5	5	7																										
180 INDIGOFERA DOSNA	9	7	8	8	2	4	6	6	7	4	4				3		3	3	+	3			2										5	5	4	5					6	5	4							4								5
57 CHEILANTHES FARINOSA	7	5	7	7	1		2	5	7	4								4	+		5	5	5			3		3		5	5		1						5	2	+	1	5	1				6	5	7	6	4	5	5	6	6	4	5
302 SACCIOLEPIS INDICA	5		5	6	6	4	6											2	1														1	2	3	5		1	2		1	+	1	+						7	2	5						2
127 EUPHORBIA HIRTA	5		5	3	2	2	1	7	5	6	8				3								+		+					4	6	5			1																2							
354 TRIUMFETTA PILOSA	7	7	5	3		+	+	4	5									+			3			2		3																																
279 PRUNELLA VULGARIS			7	5	4	5	3	7	6		9				5																	5																2	4									
281 PTERIDIUM AQUILINUM	7	7				1	+	7	5	4	6				3	5	3																							1	3	1		2				5								6	5	3
35 BIOPHYTUM SENSITIVUM	5	5			5	1	5	7	8																																																	
233 BORRERIA STRICTA	8			5	6	5	7	7	7		4					5		1			5	5							5			6								4			3														4	
158 HACKELOCHLOA GRANULARIS				8	1		2										5	1	+	+	5		1		+																							2										
111 ENGELHARDTIA SPICATA															5	6	5																			1			2	+		2	1	1				7	6						5			
90 DICRANOPTERIS LINEARIS															5	5	6			+																			+				+			4		9	7						2			
225 MURDANNIA NUDIFLORUM					+	1	1			4			2			3	3	1		+	2		+		5	5	2				4	6	5	3	5	6	5	1	1	1	6	5	2	3						2		2					2	5
359 VERNONIA CINEREA/CONYZA JAPONICA				3			1											2	2	2			1	2		2				4			4	1	1	2			+	+	5	5	1					5	3	2							5	1
217 MELASTOMA NORMALE							+										3	+		+													4	5	5	5	2	3	1	2	4	2	+	2		4							2		4			3
300 PTYCHANTHUS SP.																				3			+										1	1	4				1	+	3	6	4	2						2			2			3	4	5
77 CYPERUS ARISTATUS													2										+		1		+		3		6	5	1	5		3	3	5	+	+	3	3	3	3							2							
52 CASTANOPSIS INDICA																																7	4	2				3		1	5	5		3												5		
318 SELAGINELLA SP.																		+					1		+		1						1		3	2					1	1	+							2								5
194 KYLLINGA BREVIFOLIA					+														+														2	2	1	1		1			1	1		1														5
334 TAXITHELIUM SP.																																	1	1					+			1										2						3
286 QUERCUS GLAUCA																																			2	2			+	+																		3
238 OREOCNIDE FRUTICOSA																													3						1	2	3			1																		
237 OPLISMENUS COMPOSITUS/BURMANII																																					5	5	2	3	+			+					2									3
17 ARTHRAXON LANCIFOLIUS					+							5								+		5											2	5	5	5	5				4	3	+					2	2								2	3
298 RUBUS ELLIPTICUS																																			1	5	5			+	2	1		1		4												
264 POLYGONUM CAPITATUM																																	2	1				1	4	2			3															
147 GENTIANA CAPITATA																																	2	2				1	2	3	3	2	2															
121 ERIOCAULON NEPALENSE																																	2	2		2		1			2	1	1															
40 BULBOSTYLIS CAPILLARIS(=DENSA)						+																											2	2		1					2	1								2		2						
102 DRYOPTERIS CHRYSOCOMA																																	2	5				4	+	+	1	1	+															
97 DIGITARIA VIOLASCENS																									1													2			1	1		+														
128 EURYA ACUMINATA																																			3	1			+		2	2		1									4	2	5	3		
132 DRYOPTERIS MARGINATA																																						1			+	+	3					2	2				4		2		2	1
19 ARTHROMERIS SP.																																						1	+				1										5		5			
248 PASPALUM SCROBICULATUM				5	5	4	5		3	5	4							+		+			+		2		+						2	2	1	2	3	1		+	3	3		1														2
96 DIGITARIA SP.	5			3		1	5		5		4																																															
34 BIDENS PILOSA		5							2		4										2																				+	1										2						
358 VANDELLIA NUMMULARIFOLIA				3	+	5		4										+				3													1		1			+		+		+					2									2
219 MICROMERIA BIFLORA				3	2	1	2	6	1	6	4																									2			1		1	1	2															
76 CYNOGLOSSUM SP.							+	4		4																																+																
181 INULA CAPPA				5	+	+	1	5	4																																+																	
106 ELEPHANTOPUS SCABER							+	4	2									2	+							2																	1															
171 HYPERICUM JAPONICUM					3	2	5				4																								2	2	3				5	4	2	2														
320 SETARIA PALLIDE-FUSCA					2	2	2	5	7	4													+											2	1		1		+	+		+																
33 BIDENS BIPINNATA							1	5	7														+							4																		2	2									
317 SCUTELLARIA REPENS						+		4	6	4																																																
326 SIDA RHOMBIFOLIA					+		1		5																																																	
325 SHUTERIA VESTITIA						+	1		5																																+																	1
333 SONCHUS ASPER						1	+		1																																																	
119 ERIGERON FLORIBUNDUS/MULTICAULIS					1	+	+					2						1	3	3			+		1		2				4							1		+	1	1		1														
69 CRASSOCEPHALUS CREPIDIOIDES						+									3			1	1	+			+	2		3	4				4					1							+															
234 OLDENLANDIA CORYMBOSA					1		1		3								5	2			2	3	1	2			2	5	3	4	4											+							2									
70 CROTOLARIA ALBICA					1	1								2						+	2																																					
117 ERAGROSTIS UNILOIDES					+																		+							4					1	1		1			+	1	+	1														
293 RHUS JAVANICA												4	2	5								3						5	3				2	2							2	2		2													5	2
191 PHILONOTIS TURNERIANA																		1	5																	2					5		2														5	
306 JAMESONIELLA SP.														5				5	5		5	8										5			1	3			+		5		6						2				4		5		2	
84 DESMODIUM CONCINUUM														2	5						2	7		2		2													2		1		3										2	2	2			3
154 GLOCHIDIUM VELUTINUM															3															7	7		2					2			+			+				3					2	2		3		3
46 CAPILLIPEDIUM ASSIMILE															3			1				3	+		+			3	3	7	6	7			2						+							6										6
79 CYPERUS ROTUNDUS																	3	1		+	3		+		+		+						1																									
72 CROTOLARIA SESSILIFLORA					1										3			+		2	2			2			+												1																			
150 GERBERA SP.																					4			2		2																															2	
316 SCUTELLARIA DISCOLOR					1	1													+				+	2										1		1													2								2	
93 DIGITARIA SP.							1								3																		1			2					1		+															
188 JUSTICIA PROCUMBENS	5			3		+										5	3								1	3			3		4				1					+										2								2
22 ARUNDINELLA NEPALENSIS					1	+	1									5		1					1		+								1	1	2						1							2	5			2						1
357 VANDELLIA SP.							+						5	5	5	5		1			2	3		2	2	2	1											1											3									
18 ARTHRAXON QUARTINIANUS													6													3							3			2					3	2	+					2										
324 SHUTERIA INVOLUCRATA												4	2					+					+																									2	2									
367 WOODFORDIA FRUTICOSA																		1					1																+				2					3		5	4					3		
85 DESMODIUM CONFERTUM																									+									2					+	1	2	3	2	2						6	5	4	2	2	4			2
146 GENIOSPORUM COLORATUM																		+						4		3													2		1	1	2								2					3		
136 FICUS CUNIA							+																+																		1	+									4							
312 SCHIMA WALLICHII					1	+												1	+	3		3	1				3	3	3						1				+		+	1		+	9	9	9		7								7	
48 CAREX CRUCIATA																																			2		2		1				1										2	5			5	3
222 MICROSTEGIUM VIMINEUM																											5									2							2	1														3
349 THELYPTERIS MULTILINEATA																									+															+	1	1		1					2				2			5		
352 ORCHIDACEAE																																										1	+											4		5		2
99 DIOSCOREA GLABRA																			2	2			+				1														2	2			5	6		3	2									2
28 BARLERIA CRISTATA																					2																								5			3										
242 OSYRIS ARBOREA																																						3		1			+					6	5								2	
240 OSBECKIA NEPALENSIS	5			3	3	2	5					5	4	4	7	7	5	5	5	4	6		6	5	6	4	2			4			5	5	4	5	6	6	4	5	6	6	5	6	4	4	6	3		5	4	5	4				2	
126 EUPATORIUM ADENOPHORUM	7	8	8	7	8	8	7	8	9	7	6	4	2	5	7	7	7	8	8	8	8	9	9	9	8	9	7	9	9	8	9	9	9	9	9	9	8	9	8	8	9	9	9	8	9	9	8	6	6	8	8	7	7	7	8	7	8	9
262 POGONATHERUM CRINITUM/PANICEUM					5	4	7	7	7	8	4	9	9	9	9	9	9	9	9	8	9	9	8	7	6	6	6	9	9	9	9	9	8	8	8	7	7	7	8	8	9	9	9	8	8	9	8	9	9	9	9	9	9	9	9	9	9	9
336 SPOROBOLUS PILIFERUS	5	5	5	7	1	2	2		1				4			5	3	1			3	3	3	3	1	4	+	3	6		4			1			1				1	+										2						1
38 BRACHIARIA VILLOSA	5			7	5	5	6	8	6	5	7	2		2	5	6	3	4	5	5	3	3	3	4	4	3	5	5		7	5	6	2	3	2	4	3	1	3	1	2	2	+	+		4	4	3	4	2								2
170 HYPERICUM CORDIFOLIUM					4	1	5	7	3	9	7				3			+										3		5	4	5			2	3	3		4	3		2	5	+				6	4	2	4	2	2	2	4	7	2	5
335 SPOROBOLUS PILIFERUS																																	1								1	1																
11 ANAPHALIS TRIPLINERVIS																																							1		1		+															
189 CAMPYLOPUS SP.																																			1		5							2										2				
87 DESMODIUM MICROPHYLLUM				3			+																																			+																
249 MARCHANTIA SP.																				+			+		+																																	
98 DIOSCOREA BULBIFERA																		+												4														+														3
215 MAZUS JAPONICUS																											2										2							3														
115 ERAGROSTIS ATROVIRENS					+										3																											1																
9 ANAPHALIS CONTORTA																																								+	+	+	+															
241 OSBECKIA STELLATA																											1						1	1							+																	

Table 4.7. The most represented species in the three sections of the four groups
Tab. 4.7. Die häufigsten Pflanzenarten in den drei Sektionen der vier Gruppen

Group	Anchor	Transition	Slide
Group 1 Low altitude	Engelhardtia spicata Schima wallichii Pinus roxburghii Indigofera dosna Hypericum cordifolium Imperata cylindrica Oplismenus compositus Cheilanthes farinosa Dicranopteris linearis Pteridium aquilinum	Schima wallichii Osbeckia nepalensis Phyllanthus parvifolius Lyonia ovalifolia Eupatorium adenophorum Pogonatherum spp. Imperata cylindrica Brachiaria villosa Hackeochloa granularis Bidens bipinnata Borreria stricta Biophytum sensitivum Euphorbia hirta Triumfetta pilosa Nephrolepis cordifolium Pogonatum seminudum	**Alnus nepalensis (cult.)** Osbeckia nepalensis Eupatorium adenophorum Desmodium concinuum Schizachyrium brevifolium Pogonatherum spp. Vandellia sp. Gonostegia hirta Pogonatum junghuhnianum Jamesoniella sp. Ceratodon purpureus
Group 2 lower middle altitude generally southern aspect	Schima wallichii Lyonia ovalifolia Rhododendron arboreum Eurya acuminata Gaultheria fragrantissima Arundinella nepalensis Pogonatherum spp. Carex cruciata Roscoea purpurea Strobilanthes atropurpureus Dicranopteris linearis	Alnus nepalensis Schima wallichii Berberis aristata/asiatica Osbeckia nepalensis Osbeckia stellata Eupatorium adenophorum Arundinella nepalensis Capillipedum assimile Pogonatherum spp. Imperata cylindrica Bulbostylis capillaris Anaphalis contorta Gonostegia hirta Selaginella sp. Pogonatum seminudum	Brachiaria villosa Sporobolus piliferus Arthraxon lancifolius Eragrostis atrovirens Paspalum scrobiculatum Fimbristylis dichotoma Vandellia nummularia Polygonum nepalensis Hypericum japonicum Gentiana capitata Pogonatum junghuhnianum Ceratodon purpureus Campylopus sp.
Group 3 higher middle altitude generally northern aspect	Daphniphyllum himalayense Alnus nepalensis Eurya cerasifolia Eurya japonica Myrsine semiserrata Randia tetrasperma Neillia thyrsiflora Viburnum stellatum Arundinella nepalensis Carex cruciata Strobilanthes sp. Ellisophyllum pinnatum Roscoea purpurea Lycopodium clavatum Selaginella sp. Pteridium aquilinum Athyrium sp. Ptychanthus striatus Rhodobryum giganteum Gollania sp.	Alnus nepalensis Gaultheria fragrantissima Phyllanthus parvifolius Eupatorium adenophorum Eulalia mollis Agrostis pilosula Microstegium spp. Pogonatherum spp. Artemisia sp. Ellisiophyllum pinnatum Isodon coetsa Myriactis nepalensis Galium spp. Carex daltonii/longipes Selaginella sp. Dicranella sp. Marchantia sp.	Alnus nepalensis Eupatorium adenophorum Chambainia cuspidata Centella asiatica Drymaria diandra Anaphalis contorta Dennstaedtia appendiculata Pogonatum junghuhnianum Pogonatum seminudum Dicranella sp.
Group 4 high altitude	Quercus semecarpifolia Rhododendron arboreum Edgeworthia gardneri Berberis wallichiana Arundinella hookeri Oryzopsis lateralis Carex cruciata Commelina paludosa Cyanotis vaga Roscoea purpurea Anaphalis triplinervis Anemone rivularis Chambainia cuspidata Fragaria sp. Valeriana hardwickii Viola serpens Selaginella sp. Ectropothecinus sp.	Rubus nepalensis Agrostis pilosula Arundinella hookeri Arthraxon lancifolius Eragrostis papposa Tripogon filiformis Carex atrata Bulbostylis capillaris Anaphalis contorta Elsholtzia pilosa Gonostegia hirta Hemiphragma heterophyllum Impatiens racemosa/serrata Potentilla fulgens Pogonatum microstomum Campylopus sp.	Arthraxon lancifolius Anaphalis contorta Impatiens racemosa/serrata Pogonatum junghuhnianum Pogonatum seminudum Dicranella sp.

Veröff.Geobot.Inst.ETH,Stiftung Rübel,Zürich, **93** (1987)
R. SCHAFFNER: Vegetation of stabilizing and eroding slopes in eastern Nepal.

Table 4.8. Plant frequency at the end of the dry season 1985 on selected plots of group 1 and 2 (for legend see Table 4.1)

Tab. 4.8. Frequenz der Pflanzenarten am Ende der Trockenzeit 1985 auf ausgewählten Untersuchungsflächen der Gruppen 1 und 2 (Legende s. Tab. 4.1)

	TRANSECT NO	4			4	4	4	4	4	4
		4	8	6	0	0	4	4	4	4
	SECTION NO	3	1	1	1	2	2	4	1	5
	SECTION SYMBOL	○	○	○	○	△	△	△	□	□
NO	SPECIES									
171	HYPERICUM JAPONICUM	+	1	4						
281	PTERIDIUM AQUILINUM		5	3						
6	ALNUS NEPALENSIS	6	6							
170	HYPERICUM CORDIFOLIUM		2	2						
237	OPLISMENUS COMPOSITUS/BURMANII		1	1						
264	POLYGONUM CAPITATUM		5							
148	GENTIANA PEDICELLATA			5						
232	NEPHROLEPIS CORDIFOLIA			7						
321	SCHIMA WALLICHII			2						
293	RHUS JAVANICA			2						
217	MELASTOMA NORMALE			3						
52	CASTANOPSIS INDICA			3						
115	ERAGROSTIS ATROVIRENS	+	+		+					
11	ANAPHALIS TRIPLINERVIS	+			+					
124	EULALIA SP.				2					
22	ARUNDINELLA NEPALENSIS		1	1	7					
194	KYLLINGA BREVIFOLIA		1	5	+	3				
177	IMPERATA CYLINDRICA		+	5	7	9				
219	MICROMERIA BIFLORA			1	3	2				
248	PASPALUM SCROBICULATUM		1	1		2				
9	ANAPHALIS CONTORTA				7	7				
145	GAULTHERIA FRAGRANTISSIMA				1	7				
48	CAREX CRUCIATA					3				
284	PYRUS PASHIA					5				
241	OSBECKIA STELLATA				2	2				
243	OXALIS CORNICULATA				1	2				
30	BERBERIS ARISTATA/ASIATICA						7			
359	VERNONIA CINEREA	1		5		2	5			
240	OSBECKIA NEPALENSIS	1	3	6			7			
111	ENGELHARDTIA SPICATA			1			8		9	
156	GONOSTEGIA HIRTA		+	2	+			5		
210	LYONIA OVALIFOLIA			2				5		9
90	DICRANOPTERIS LINEARIS							8		7
229	MYRSINE CAPITELLATA							5		7
56	LABIATAE ?									5
360	VIBURNUM CORIACEUM									5
292	RHODODENDRON ARBOREUM									5
120	ERIOBOTHRYA DUBIA									7
262	POGONATHERUM CRINITUM/PANICEUM		3	9	2	2		5		7
126	EUPATORIUM ADENOPHORUM	6	5	8	3	3	5	7	9	
273	POGONATUM JUNGHUHNIANUM			+	5	2			4	
253	PHYLLANTHUS PARVIFOLIUS			6	+					6
349	THELYPTERIS MULTILINEATA			1						
302	SACCIOLEPTIS INDICA			1						
300	PTYCHANTHUS SP.			1						
298	RUBUS ELLIPTICUS			1						
128	EURYA ACCUMINATA			1						
102	DRYOPTERIS CHRYSOCOMA			1						
77	CYPERUS ARISTATUS			1						
57	CHEILANTHES FARINOSA			1						
18	ARTHRAXON QUARTINIANUS			1						

Species found scarcely (freq. 1%) in only one slide section:

Cyanotis vaga, Oxyspora paniculata, Lycopodium clavatum, Litsea polyantha, Desmodium confertum, Desmodium concinuum, Capillipedum assimile, Maesa macrophylla, Saccharum spontaneum, Prunus pashia, Flemingia strobilifera, Conyza stricta

Veröff.Geobot.Inst.ETH,Stiftung Rübel,Zürich, 93 (1987)

Table 4.9. Plant frequency at the end of the dry season 1985 on selected plots of group 3 and 4 (for legend see Table 4.1)

Tab. 4.9. Frequenz der Pflanzenarten am Ende der Trockenzeit 1985 auf ausgewählten Untersuchungsflächen der Gruppen 3 und 4 (Legende s. Tab. 4.1)

	TRANSECT NO	2	2	2	2	2	2	2	2	3	2	2	2	3	3	2	2	2	3
		1	1	1	1	1	3	3	7	3	1	1	3	3	3	1	1	3	3
	SECTION NO	4	6	7	3	5	3	4	1	3	8	2	2	2	4	1	9	1	5
	SECTION SYMBOL	○	○	○	○	○	○	○	○	○	△	△	△	△	△	□	□	□	□
NO	SPECIES																		
198	LEDANTHUS PEDUNCULARIS	5		1															
169	HYDROCOTYLE NEPALENSIS			3	3	5	3	3											
205	LITSEA CUBEBA				1	1													
260	PLANTAGO MAJOR				3		2												
83	DENNSTAEDTIA APPENDICULATA				3	1	1												
21	ARUNDINELLA HOOKERI							1	5										
74	CYANOTIS VAGA				1					1									
281	PTERIDIUM AQUILINUM								2	1									
263	POLYGALA TRIPHYLLA			9							7								
6	ALNUS NEPALENSIS		5		7	3				5		4							
9	ANAPHALIS CONTORTA						7	8	7	4			7						
141	FRAGARIA SP.				2	2	2	3					5						
47	CAREX ATRATA			8		1	2	5	6	1			5	5	3				
116	ERAGROSTIS PAPPOSA			3			3	5	5	7			5	7	6				
227	MYRIACTIS NEPALENSIS			5				1		3			5	2					
273	POGONATUM JUNGHUHNIANUM					2	1		4					4					
210	LYONIA OVALIFOLIA						3	5						7					
243	OXALIS CORNICULATA									7				4	2				
276	POTENTILLA FULGENS							2	1					2	2				
156	GONOSTEGIA HIRTA								1	2					5				
43	CALAMINTHE UMBROSUM			5			3	1		4					5		7		
164	HEMIPHRAGMA HETEROPHYLLUM					1	5	7	5	6			5	7	2		2		
182	ISACHNE ALBENS						1						7					9	
194	KYLLINGA BREVIFOLIA												5					4	
48	CAREX CRUCIATA						1	2	+			5			5				4
304	SAMBUCUS ADNATA											7				2			
364	VIOLA SERPENS											4				2			
361	VIBURNUM ERUBESCENS					2										5	4	5	4
294	RHUS SUCCEDANEA														4				9
149	GERANIUM NEPALENSE														2		4		
82	DAPHNIPHYLLUM HIMALAYENSE																8		
87	DESMODIUM MICROPHYLLUM																	7	
104	EDGEWORTHIA GARDNERI																	9	
292	RHODODENDRON ARBOREUM																		7
288	QUERCUS SEMECARPIFOLIA																		9
55	CHAMBAINIA CUSPIDATA	3	8		7	8	7	6	+	4	9	4	8	7		9	7	9	5
337	STELLARIA PATENS			3	2	3	3		+	1					2	5		4	
126	EUPATORIUM ADENOPHORUM				5	5	1	1		1				7	3	5			7
144	GALIUM SP.					3	6	1		6				6	7		6		4
298	RUBUS ELLIPTICUS				5	2						4				4			
4	AGROSTIS PILOSULA				1				+	5					2		2		4
319	SENECIO DENSIFLORUM									5					6				4
267	POLYGONUM UNCINATUM				4	5				6		6		5	5	6	5		5
173	HYPERICUM URALUM				6	1				2		8		2		4			
107	ELLISIOPHYLLUM PINNATUM			5	5	5						8				5	8		
221	MICROSTEGIUM NUDUM		5		7	8		1		6		9		6	7	4	8		4
340	STROBILANTHES SP.						2	5								4			7
50	CAREX NUBIGENA			6					2								2		
8	ANAPHALIS BUSUA				1					4					2				
5	AJUGA LOBATA			5		5					5						4		
23	ASTILBE RIVULARIS				2											2			
342	SWERTIA SP.						1			1					2			4	
249	MARCHANTIA SP.				5								5					4	
299	RUBUS NEPALENSIS/FOCKEANUS						8	7					9					5	

Species found only in one section:

Anchor: Tetrastigma serrulatum, Phyllanthus flueggeiformis, Pratia nummularia, Elsholtzia flava

Transition: Boenninghausenia albiflora, Dryopteris lepidopoda, Rubia charaefolia, Centella asiatica, Arundinella nepalensis

Slide: Sonchus asper, Impatiens racemosa, Conyza japonica, Scirpus sedateus, Mazus japonicus, Sporobolus piliferus, Conyza stricta, Carex daltonii, Bulbostylis capillaris, Anaphalis triplinervis, Leucosceptrum canum, Zanthoxylum acanthopodium, Cyperus rotundus

Table 4.10. Plant frequency in early monsoon 1985: Group 1 (for legend see Table 4.1)

Tab. 4.10. Frequenz der Pflanzenarten am Anfang des Monsuns 1985 auf den Untersuchungsflächen der Gruppe 1 (Legende s. Tab. 4.1)

TRANSECT NO	1	1	5	2	1	2	3	4	4	4	5	6	7	1	2	7	7	1	2	4	4	5	7	7
SECTION NO	2	4	2	2	3	3	1	2	3	4	1	1	3	5	4	2	4	1	1	1	5	3	1	5
SECTION SYMBOL	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	□	□	□	□	□	□	□
NO SPECIES																								
6 ALNUS NEPALENSIS	7	8		5	8	7	7						5											
84 DESMODIUM CONCINUUM	2	5			2					1		+												
79 CYPERUS ROTUNDUS	2				2							+												
273 POGONATUM JUNGHUHNIANUM		7			3	2	1		2	5	1	3												
306 JAMESONIELLA SP.		5	8			1	2			5	2	3												
214 CERATODON PURPUREUS				3			2	2				+	+											
336 SPOROBOLUS PILIFERUS						2	2			+		+											1	
94 DIGITARIA ASCENDENS						+				+	1									1				
136 FICUS CUNIA							+	2				1												
222 MICROSTEGIUM VIMINEUM									3	1	2	1								3				
171 HYPERICUM JAPONICUM										2	3	4	3											
217 MELASTOMA NORMALE									1	+	5	2	+											
298 RUBUS ELLIPTICUS									1		5	1												
119 ERIGERON FLORIBUNDUS						3	1	2	2			3	1	4										
313 SCHIZACHYRIUM BREVIFOLIUM					5	3	6	2	1	6	5	3		4										
240 OSBECKIA NEPALENSIS	5	3		6	6	4	5	5	5	5	4	6	3	4	4		5		3		2			3
33 BIDENS BIPINNATA						+			1	+			1			5			5	3				
312 SCHIMA WALLICHII					2	3	+			1		+			9			7			7			
352 ORCHIDACEAE						+															5		1	3
354 TRIUMFETTA PILOSA						1							+			4	5						3	5
49 CAREX DALTONII/LONGIPES							+												2	1	2			
48 CAREX ATRATA			2							+		1								3	4			
286 QUERCUS GLAUCA										1	2									3	5			
132 DRYOPTERIS MARGINATA										+		+						2	5	2	5	3		
242 OSYRIS ARBOREA										+								4	6			3		
281 PTERIDIUM AQUILINUM												2				4	5		3	2	2	5	3	
116 ERAGROSTIS PAPPOSA													+					2					2	
181 INULA CAPPA													1					3		1			3	
233 BORRERIA STRICTA													4			6							6	
35 BIOPHYTUM SENSITIVUM													2			7	5						7	
127 EUPHORBIA HIRTA													1	6		6							3	3
96 DIGITARIA SP.													4			4	5						5	3
258 PINUS ROXBURGHII													5	5			9		3				7	9
325 SHUTERIA VESTITIA																				2			4	3
126 EUPATORIUM ADENOPHORUM	4	7	6	5	7	8	8	5	8	7	8	8	5	6	8	7	5	5	5	8	2	5	6	5
262 POGONATHERUM CRINITUM/PANICEUM	9	9	9	9	8	9	8	9	8	8	7	9	5	9	9	6		9	9	8	9	9	7	
57 CHEILANTHES FARINOSA		5	4		3		3	6		4	1	1	1			4		5	6	5		5	6	7
17 ARTHRAXON LANCIFOLIUS	2			5		1	3		1	+	1	2	2			6		3	3				6	7
38 BRACHIARIA VILLOSA				3		2	2			+	4	3	5	4		7		3		1			7	5
177 IMPERATA CYLINDRICA				6	5	1	6		6	3	6	5	1					8	8		6	3	5	
170 HYPERICUM CORDIFOLIUM			4	3		1		4		5	2		4			8		4	5	4		6	2	
99 DIOSCOREA GLABRA			4			2	1		3	1	2	3			4			2	5	5	5	7	2	
232 NEPHROLEPIS CORDIFOLIA			8	3		4	+	4	5	5	5	6			6				6	8	8	8		
253 PHYLLANTHUS PARVIFOLIUS			8		5		1	2	6	7	5	6		4				5	2	6	7	5		
210 LYONIA OVALIFOLIA		5	8	5		+			2	5		2							5	5	6	7		
138 FIMBRISTYLIS DICHOTOMA				3	3	5	2		6	6	7	7								5	4			
146 GENIOSPORUM COLORATUM			6		2					1	1	2								2	4	3		
293 RHUS JAVANICA	2	3							2			1									2	5		
156 GONOSTEGIA HIRTA			4	5	6	2	5	5	6	5	3	3	+	6				2		5	2	3		
180 INDIGOFERA DOSNA					3				2		3					5				2	2		3	3
248 PASPALUM SCROBICULATUM					2	1	+		2	1	5	4	5							3		3	1	3
305 POGONATUM SEMINUDUM							1	6	5	3	2	+	1			4			2	1			4	3
194 KYLLINGA BREVIFOLIA						1	1		2		2	1	1				5			2			3	
302 SACCIOLEPIS INDICA							1	2	1	1	2	2	2										5	3
219 MICROMERIA BIFLORA										1	1	1	1			4							1	5
40 BULBOSTYLIS CAPILLARIS											1	2								1				3
225 MURDANNIA NUDIFLORUM				5		+	1		5		5		+	4		4			5	3				
46 CAPILLIPEDUM ASSIMILE				5			1							8					5	5				
359 VERNONIA CINEREA						2	2				3	6							2		2			
98 DIOSCOREA BULBIFERA					5	1	1					1		7				5	2					
22 ARUNDINELLA NEPALENSIS	4						2	4	1		1		1					3	5					
111 ENGELHARDTIA SPICATA			5	6						2		1						6	6					
300 PTYCHANTHUS SP.									2	4	4	2								2	2	5		
154 GLOCHIDION VELUTINUM				5					2			+						2	2	3		3		
85 DESMODIUM CONFERTUM			5					2	2	1		+						3		1				
324 SHUTERIA INVOLUCRATA	4						+							4					2					
52 CASTANOPSIS INDICA									2			4						4			2			
345 SYZYGIUM CUMINI			5															2		1				
28 BARLERIA CRISTATA					2	+													2	1				
367 WOODFORDIA FRUTICOSA							1	2		+									2					
331 SMITHIA CILIATA						2	1				1	4							2					
90 DICRANOPTERIS LINEARIS			2							+								7	8					
349 THELYPTERIS MULTILINEATA			4								1	+						2						
275 LITSEA SP?			2							1								2						
316 SCUTELLARIA DISCOLOR											2		1					2						
128 EURYA ACUMINATA			5								1	1												
237 OPLISMENUS COMPOSITUS/BURMANII									3			1								5				
334 TAXITHELIUM SP.									1		1									3				
143 GALINSOGA PARVIFLORA/CILIATA							1					+											5	
70 CROTALARIA ALBIDA						+							+										1	
320 SETARIA PALLIDE-FUSCA							1				2	1	1										2	
106 ELEPHANTOPUS SCABER							1					+	+			4							1	

Species only found in one or two sections:

Anchor: Bidens pilosa, Polygonum sp?, Maoutia puya, Triumfetta rhomboidea, Premna sp., Labiatae 2, Maoutia puya, Castanopsis tribuloides, Clematis buchanania, Smilax sp., Oxalis corniculata, Selaginella sp., Litsea polyantha, Gonatanthus pumilus, Arisaema erubescens, Castanopsis tribuloides, Zingiberaceae, Cynoglossum sp., Laggera alata, Justicia procumbens, Hypoxis aurea, Cyanotis vaga, Vandellia nummularifolia, Sida rhombifolia, Scutellaria repens, Hackeochloa granularis

Transition: Gerbera sp., Labiatae 2, Scutellaria repens

Slide: Pavetta tomentosa, Gerbera sp., Bidens pilosa, Polygonum uncinatum, Labiatae 1, Impatiens racemosa, Philonotis turneriana, Oxalis corniculata, Dryopteris chrysocoma, Indigofera atropurpurea, Polygonum capitatum, Oxyspora paniculata, Anaphalis triplinervis, Impatiens racemosa, Philonotis turneriana, Drymaria diandra, Oreocnide fruticosa, Arthromeris sp., Hedyotis scandens, Clematis sp., Berberis aristata, Indigofera atropurpurea, Litsea polyantha, Anaphalis triplinervis, Hemarthria compressa, Eulalia sp., Digitaria violascens, Drymaria diandra, Cynoglossum sp., Sphenomeris chinensis, Sida rhombifolia

Table 4.11. Soils, parent materials and landforms of Lamosangu-Kharidhunga area (after ESPINOSA 1975)
Tab. 4.11. Böden, Muttergestein und Relief im Gebiet von Lamosangu-Kharidhunga (nach ESPINOSA 1975)

Parent materials	Soil series	Main landform characteristics
Metamorphosed sandstone in situ	Guchchhe, Lapse	Steep to very steep hills. Severe soil/rock creep in places
Soil material derived from metamorphosed sandstone in situ	Lapse	nearly level bench terraces on or near hill summits
Phyllite in situ	Deorali, Golme Danda	Steeply dissected ridges with some undulating summits
Soil material derived from phyllite in situ	Golme Danda, Kharka, Parebha, Sunkhani	Nearly level bench terraces in steep mountainous areas
Alluvium/colluvium derived from metamorphosed sandstone and phyllite	Bhalukhop, Birta Besi Birta Pakhar, Timbure	Nearly level bench terraces on moderately steep to steep colluvial slopes
Rock/soil creep material: metamorphosed sandstone and phyllite	Kaping	Very steep, dissected hills
Soil material derived from metamorphosed sandstone and phyllite in situ	Dhuseni, Kathaike, Mesipo, Pedku, Ratankot	Nearly level bench terraces in steep hilly areas
Augen gneiss (feldspatic schist) in situ	Sarai Danda	Steep to very steep, dissected mountains. Severe soil/rock creep in places
Colluvium derived from augen gneiss (feldspatic schist)	Girke Danda	Nearly level bench terraces on steep, dissected colluvial slopes
Soil material derived from augen gneiss (feldspatic schist) in situ	Chanaute, Chitre, Pakha Deb, Sarai Danda Sarangthali, Tauthali	Nearly level bench terraces in steep to very steep mountainous areas
Soil material derived from carbonaceous slate in situ	Burana	Ditto
Soil material derived from metamorphosed limestone in situ	Onchi	Ditto
Magnesite with talc lenses in situ	Kharidhunga	Steep to very steep, dissected mountainous areas
Alluvium/colluvium derived from chlorite schist; talc and iron oros	Khari, Mane	Nearly level bench terraces in rolling basin, probably of a synelinorium type

Note: Golme Danda, Lapse and Sarai Danda series occur on both bench terraces and non-terraced slopes.

Table 4.12. Soil classification of Lamosangu-Kharidhunga area (after ESPINOSA 1975)
Tab. 4.12. Klassifikation der Böden im Gebiet von Lamosangu-Kharidhunga (nach ESPINOSA 1975)

USDA SOIL CLASSIFICATION, 7th APPROXIMATION				Soil series	Legend of the FAO/UNESCO Soil Map of the World
Order	Suborder	Great Group	Subgroup		
Entisols	Aquents	Haplaquents	Typic Haplaquents	Timbure	Dystric Gleysols
	Orthents	Udorthents	Typic Udorthents	Girkha Danda	Dystric Regosols
Inceptisols	Aquepts	Haplaquepts	Typic Haplaquepts	Birta Besi	Dystric Gleysols
			Fluventic Haplaquepts	Birta Pakhar	Dystric Gleysols
	Ochrepts	Dystrochrepts	Typic Dystrochrepts	Dhuseni, Lapse,	Dystric Cambisols
				Khari, Kathaike	Dystric Cambisols
			Aquic Dystrochrepts	Balukhop, Kharka	Dystric Gleysols
			Fluventic Dystrochrepts	Chitre, Mesipo, Pedku	Dystric Cambisols
			Lithic Dystrochrepts	Kaping, Pakha Deb	Dystric Cambisols
			Rhodic Dystrochrepts	Deorali 1	Dystric Cambisols
		Eutrochrepts	Dystric Eutrochrepts	Onchi	Eutric Cambisols
	Umbrepts	Haplumbrepts	Typic Haplumbrepts	Guchchhe, Sarangthali	Humic Cambisols
			Cumulic Haplumbrepts	Burana , Chanaute	Humic Cambisols
				Mane, Ratankot	
Alfisols	Udalfs	Hapludalfs	Typic Hapludalfs	Golme Danda 2	Orthic Acrisols
				Parebha 2	
				Sunkhani 2	Orthic Acrisols
				Thautali 2	
			Mollic Hapludalfs	Sarai Danda	Humic Acrisols
				Kharidhunga	Humic Acrisols

1 Integrade between Dystrochrepts and Rhodustalfs
2 May be ultic Hapludalf if base saturation is less than 60% at 125 cm below the top of the argillic horizon, or in a layer above hard rock if shallower.

Table 4.13. Soil survey of study area
Tab. 4.13. Ergebnisse aus den Bodenuntersuchungen im Untersuchungsgebiet

A1 anchor/position in transect
T2 transition/position in transect
S1 slide/position in transect

1) 1 = 0.0356 mg P_2O_5/100 g dry soil

2) 1 = 1.0 mg K_2O/100 g dry soil

* for CEC-value see Table 4.14

Plot No	Transect No	Section	Altitude a.s.l.	Aspect 0-400°	Texture/Humus (estimated)	pH (Hellige)	pH (H_2O)	P_2O_5 1)	K_2O 2)	Texture/Humus (measured) Clay%	Silt%	Sand%	Humus%	CEC	Soil Serie ESPINOSA	Vegetation Type
1	2	A 1	1130 m	375	sandy loam with little humus	5.0	6.0	4.0	6.3						Kaping series: dystric Cambisol	overexploited broadleave forest
1	2	S 1	1130 m	375	sandy loam with little humus	5.0	6.0	4.0	1.5	10.6	36.6	49.7	3.1		dystric Regosol	
1	2	T 2	1130 m	375	sand poor in humus		6.1	1.5	3.4						dystric Regosol	
1	3	S 1	1130 m	375	sand poor in humus	5.0	6.2	0.6	0.9						dystric Regosol	
2	4	A 1	1180 m	375	loamy sand with little humus	5.0	6.1	2.1	2.7						Kaping series: dystric Cambisol	overexploited forest/shrubland
2	4	A 2	1180 m	375	loamy sand with little humus		5.8	2.6	2.1						dystric Cambisol	overexploited forest/shrubland
2	4	S 1	1180 m	375	sand poor in humus		6.1	1.2	0.5						dystric Regosol	
2	4	S 2	1180 m	375	loamy sand poor in humus	5.0	6.3	1.5	1.1						dystric Regosol	
3	7	A 1	1450 m	225	sandy loam poor in humus	5.0	6.0	0.2	2.5						Lapse series: dystric Cambisol	Pinus roxburghii forest
3	7	A 2	1450 m	225	sandy loam poor in humus	5.0	5.9	0.6	2.0						dystric Cambisol	Pinus roxburghii forest
3	7	S 1	1450 m	225	loamy sand poor in humus	5.0	5.8	0.2	1.2	11.6	36.6	51.5	0.7		dystric Regosol	
4	8	S 1	1690 m	150	sand poor in humus	5.0	5.7	0.1	0.5						dystric Regosol	
4	8	A 2	1690 m	150	sandy loam with little humus	5.0	5.6	0.6	0.5						Golme danda s: orthic Acrisol	uncultivated terrace
5	8	S 1	1680 m	200	loamy sand poor in humus	5.0	6.4	5.2	2.4						dystric Regosol	
6	10	A 2	1800 m	250	loamy sand poor in humus	5.0	5.4	0.9	2.2						Golme danda s: orthic Acrisol	broadleave forest
6	10	S 1	1800 m	250	sand poor in humus	5.0	5.7	0.3	0.3						dystric Regosol	
6	10	T 1	1800 m	250	loamy sand poor in humus		5.6	0.2	0.6						dystric Regosol	
7	11	A 1	1980 m	300	loamy sand with humus	4.5	5.6	0.5	0.8	12.0	34.6	48.0	5.4		Guchchhe s: humic Cambisol	afforested with Pinus patula
7	11	A 2	1980 m	300	sandy loam with humus		5.4	1.6	0.9						humic Cambisol	afforested with Pinus patula
7	11	S 1	1980 m	300	sand poor in humus	4.8	5.5	0.1	0.4	6.8	31.8	60.7	0.7		dystric Regosol	
8	12	A 1	1990 m	350	sandy loam with humus		5.2	2.0	1.8						Guchchhe s: humic Cambisol	overexploited broadleave forest
8	12	A 2	1990 m	350	sandy loam with little humus	4.5	5.5	1.6	1.7						humic Cambisol	overexploited broadleave forest
8	12	S 1	1990 m	350	sand poor in humus	4.5	5.4	0.2	0.2						Lithosol	
9	14	A 1	1990 m	75	loamy sand poor in humus		5.5	0.1	0.4						dystric Regosol	shrubland
9	14	S 1	1990 m	75	loamy sand poor in humus	5.0	5.6	0.1	1.3						Lithosol	
10	15	A 1	2010 m	400	loamy sand with little humus		7.0	0.5	2.3						Golme danda s: orthic Acrisol	shrubland
10	15	A 2	2010 m	400	loamy sand poor in humus	4.5	7.2	0.1	0.4						orthic Acrisol	shrubland
10	15	S 1	2010 m	400	loamy sand poor in humus	5.0	7.6	0.3	1.1						dystric Regosol	
11	16	A 2	2040 m	250	sandy loam with humus	6.0	6.7	0.9	0.6						Golme danda s: orthic Acrisol	overexploited broadleave forest
11	17	A 1	2040 m	250	sandy loam poor in humus		7.5	0.4	3.0	10.0	29.6	58.6	1.8		orthic Acrisol	grassland
11	18	S 1	2040 m	250	sand poor in humus	5.0	7.8	0.3	0.3	2.0	23.2	74.3	0.5		dystric Regosol	
12	19	S 1	2030 m	200	sandy loam poor in humus	7.5	7.7	0.2	1.0						Golme danda s: calcaric Regosol	
13	20	S 1	2100 m	250	sandy loam with little humus	5.0	5.7	0.2	0.4						Golme danda s: dystric Regosol	
14	21	A 1	2130 m	25	sandy loam poor in humus		6.1	0.5	0.9						Burana series: humic Cambisol	overexploited broadleave forest
14	21	A 2	2130 m	25	sandy loam with humus	5.0	5.5	0.6	2.1						humic Cambisol	broadleave forest
14	21	S 1	2130 m	25	loamy sand with humus	5.0	6.6	0.2	0.6						dystric Regosol	
14	21	S 2	2130 m	25	sandy loam with little humus	4.8	6.5	0.7	0.6						dystric Regosol	
15	22	A 1	2180 m	325	sandy loam with little humus		5.5	0.3	0.4						Burana series: humic Cambisol	shrubland
15	22	R 2	2180 m	325	sandy loam poor in humus	5.0	5.0	1.1	4.4						Lithosol	
15	22	A 1	2180 m	325	sandy loam with humus	4.0	4.5	0.8	0.7						Burana series: humic Cambisol	overexploited broadleave forest
16	23	A 1	2570 m	250	loamy sand with little humus	4.5	5.4	0.6	0.5						Sarai danda s: humic Acrisol	shrubland
16	23	S 1	2570 m	250	sand poor in humus	5.0	4.5	0.6	0.8						dystric Regosol	
17	24	A 1	2620 m	100	sandy loam with little humus	4.5	4.9	0.2	0.6						Sarai danda s: humic Cambisol	
17	24	A 2	2620 m	100	sandy loam with humus		4.6	0.7	1.3						humic Cambisol	grassland
17	24	S 1	2620 m	100	sandy loam poor in humus	5.0	5.3	0.0	0.2						Lithosol	
18	25	A 1	2560 m	125	sandy loam with little humus	5.0	5.3	0.4	1.1						Chitre series: dystric Cambisol	uncultivated terrace
18	25	A 2	2560 m	125	sandy loam with humus		5.0	0.6	0.8						dystric Cambisol	shrubland
18	25	S 1	2560 m	125	sandy loam poor in humus	4.8	5.3	0.1	0.2						Lithosol	
19	27	A 1	2500 m	150	sandy loam with humus	4.3	4.9	0.6	0.9						Chitre series: dystric Cambisol	shrubland
19	27	S 2	2500 m	150	sandy loam with little humus	5.0	4.5	0.1	0.4						dystric Regosol	
20	28	S 1	2500 m	150	sand poor in humus	5.0	5.6	0.1	0.4						dystric Regosol	
21	29	A 2	2530 m	150	loam with humus	4.7	5.1	0.2	0.2	24.4	45.0	22.2	8.4		Chitre series: dystric Cambisol	grassland
21	29	S 1	2530 m	150	loamy sand poor in humus	5.0	5.6	0.0	0.4	12.4	13.8	73.3	0.5		Lithosol	
22	30	A 1	2590 m	275	sandy loam with little humus		5.0	0.3	1.1						Sarai danda s: humic Acrisol	overexploited Quercus semecarp.forest
22	30	A 2	2590 m	275	loam rich in humus	4.5	5.9	1.3	0.5	20.3	31.7	36.2	11.8		humic Acrisol	overexploited Quercus semecarp.forest
22	30	S 1	2590 m	275	sandy loam with humus	4.5	5.0	0.2	0.6	10.4	30.0	52.3	7.3		Regosol	
22	30	S 2	2590 m	275	loamy sand poor in humus	5.0	5.5	0.3	0.2						Regosol	
23	32	A 2	2450 m	275	sandy loam with little humus	4.5	5.2	0.9	1.5						Sarai danda s: humic Acrisol	shrubland
23	32	S 1	2450 m	275	loamy sand with little humus	5.5	5.0	0.2	0.6						dystric Regosol	
24	33	A 1	2350 m	200	sandy loam with little humus		5.3	2.0	1.3						Sarai danda s: humic Acrisol	shrubland
24	33	A 2	2350 m	200	sandy loam with little humus	4.5	5.2	1.5	2.7						humic Acrisol	overexploited broadleave forest
24	33	S 1	2350 m	200	sandy loam with humus	5.0	5.6	1.3	1.9						Regosol	
25	34	A 1	2100 m	50	loam poor in humus		5.4	0.1	1.1						Golme danda s: orthic Acrisol	grassland
25	34	A 2	2100 m	50	sandy loam poor in humus	4.5	5.5	0.5	1.3						orthic Acrisol	shrubland
25	34	S 1	2100 m	50	loam with little humus	4.7	5.2	2.3	0.2						dystric Regosol	
26	35	A 1	2090 m	125	loamy sand poor in humus		4.9	0.3	2.0						Golme danda s: orthic Acrisol	grassland
26	35	A 2	2090 m	125	loam rich in humus	4.5	4.6	0.4	0.8	25.2	45.0	19.5	10.3		orthic Acrisol	shrubland
26	35	S 1	2090 m	125	sand poor in humus	5.5	5.5	0.1	0.2						dystric Regosol	
26	35	S 2	2090 m	125	sandy loam poor in humus	5.0	5.3	0.2	0.2	12.8	30.0	55.6	1.6		Lithosol	
27	36	S 3	2000 m	175	sand poor in humus		6.1	0.3	0.4						dystric Regosol	
27	37	A 1	2000 m	175	loamy sand with little humus	4.5	5.2	0.3	1.1						Golme danda s: orthic Acrisol	cultivated terrace
27	37	A 2	2000 m	175	loamy sand poor in humus		5.4	0.2	2.2						orthic Acrisol	cultivated terrace
27	37	S 1	2000 m	175	loamy sand poor in humus		5.6	0.1	0.6						dystric Regosol	
27	37	S 2	2000 m	175	loamy sand poor in humus	5 0	5.4	0.2	0.9						dystric Regosol	
28	38	A 1	1950 m	210	loamy sand with little humus	4.5	5.5	0.8	2.0	10.4	21.4	63.2	5.0		Girka danda s: dystric Regosol	grassland
28	38	A 2	1950 m	210	sand with little humus		5.3	0.5	1.4	9.0	23.4	64.8	2.8		dystric Regosol	shrubland
28	38	S 1	1950 m	210	sand poor in humus	5.0	6.1	0.3	0.4						dystric Regosol	
29	39	A 1	1890 m	250	loamy sand poor in humus	4.5	5.5	0.5	2.4						Guchchhe s: humic Cambisol	overexploited broadleave forest
29	39	S 1	1890 m	250	loamy sand with little humus	5.0	5.4	0.4	0.9						dystric Regosol	
29	39	S 2	1890 m	250	sand poor in humus		5.6	0.1	0.3						dystric Regosol	
30	40	A 2	2050 m	290	loamy sand with little humus	5.0	5.4	0.5	0.7						Sarai danda s: humic Acrisol	grassland
30	40	AB	2050 m	290	loamy sand with little humus	5.0	5.4	0.9	2.2						humic Acrisol	shrubland
30	40	S 1	2050 m	290	loamy sand poor in humus	5.0	5.5	0.0	0.2						Lithosol	
31	41	A 2	2020 m	300	loamy sand poor in humus	4.5	5.5	0.2	1.1						Guchchhe s: humic Cambisol	shrubland
31	41	S 1	2020 m	300	loamy sand poor in humus	5.0	5.3	0.1	0.5						Regosol	
32	42	S 1	1800 m	175	sand poor in humus	5.0	5.8	0.3	1.4						dystric Regosol	
32	42	S 2	1800 m	175	sand poor in humus		6.0	0.4	0.6						dystric Regosol	
33	43	AB	1750 m	200	loamy sand poor in humus	5.5	5.9	1.3	3.4						Deorali s: chromic Cambisol	shrubland
33	43	S 1	1750 m	200	sand poor in humus	5.0	6.0	0.2	0.8						Lithosol	
34	44	A 2	1730 m	200	loamy sand with humus	5.0	5.7	0.6	3.7	14.4	20.4	56.2	9.0		Deorali s: chromic Cambisol	overexploited broadleave forest
34	44	S 1	1730 m	200	sand with little humus	5.0	5.6	0.1	0.7	5.2	21.3	73.1	0.4		Regosol	
35	45	A 1	1730 m	300	sand with little humus		5.8	0.5	3.8						Deorali s: chromic Cambisol	overexploited broadleave forest
35	45	S 1	1730 m	300	sand with little humus	5.0	6.0	0.1	0.8						Regosol	
s 1				225	sandy loam poor in humus	5.0	5.9								Lapse series: dystric Cambisol	Pinus roxburghii forest
s 2			1570 m	225	loamy sand poor in humus	5.0	5.8	0.3	2.1						Lapse series: dystric Cambisol	Pinus roxburghii forest
s 3			1700 m	225	sandy loam poor in humus	5.0	5.7	0.3	0.8	11.6	34.2	52.2	2.0	*	dystric Regosol	shrubland
s 4			1710 m	300	loam with humus	4.5	5.3	0.9	3.0	23.8	35.2	35.4	5.6	*	Guchchhe s: humic Cambisol	broadleave forest
s 5				250	loamy sand poor in humus	5.0	5.7								Deorali s: chromic Cambisol	broadleave forest
s 6			1800 m	200	loamy sand with little humus	5.0	5.8	1.2	2.0						Deorali s: chromic Cambisol	shrubland
s 7				175	loamy sand poor in humus	5.5	5.9								Deorali s: chromic Cambisol	shrubland
s 8			1800 m	250	loamy sand with little humus	5.0	5.4	0.7	1.8						Golme danda s: orthic Acrisol	broadleave forest
s 9			2050 m	150	silt with humus	5.0	5.8	1.0	3.1	27.6	52.0	12.3	8.1	*	Guchchhe s: humic Cambisol	grassland
s10				300	loamy sand with little humus		5.4								Guchchhe s: humic Cambisol	shrubland
s11			2100 m	200	loamy sand with humus	5.6	5.6	0.2	0.4	19.0	36.8	38.1	6.1	*	Golme danda s: orthic Acrisol	grassland
s12a			2280 m	400	loam rich in humus	4.2	5.3	2.2	4.8	23.8	31.2	30.9	14.1	*	Guchchhe s: humic Cambisol	broadleave forest
s13				250	loam rich in humus	4.5	4.9								Sarai danda s: humic Acrisol	overexploited Quercus semecarp.forest

Parent materials	Soil series	Main landform characteristics
Metamorphosed sandstone in situ	Guchchhe, Lapse	Steep to very steep hills. Severe soil/rock creep in places
Soil material derived from metamorphosed sandstone in situ	Lapse	nearly level bench terraces on or near hill summits
Phyllite in situ	Deorali, Golme Danda	Steeply dissected ridges with some undulating summits
Soil material derived from phyllite in situ	Golme Danda, Kharka, Parebha, Sunkhani	Nearly level bench terraces in steep mountainous areas
Alluvium/colluvium derived from metamorphosed sandstone and phyllite	Bhalukhop, Birta Besi Birta Pakhar, Timbure	Nearly level bench terraces on moderately steep to steep colluvial slopes
Rock/soil creep material: metamorphosed sandstone and phyllite	Kaping	Very steep, dissected hills
Soil material derived from metamorphosed sandstone and phyllite in situ	Dhuseni, Kathaike, Mesipo, Pedku, Ratankot	Nearly level bench terraces in steep hilly areas
Augen gneiss (feldspatic schist) in situ	Sarai Danda	Steep to very steep, dissected mountains. Severe soil/rock creep in places
Colluvium derived from augen gneiss (feldspatic schist)	Girke Danda	Nearly level bench terraces on steep, dissected colluvial slopes
Soil material derived from augen gneiss (feldspatic schist) in situ	Chanaute, Chitre, Pakha Deb, Sarai Danda Sarangthali, Tauthali	Nearly level bench terraces in steep to very steep mountainous areas
Soil material derived from carbonaceous slate in situ	Burana	Ditto
Soil material derived from metamorphosed limestone in situ	Onchi	Ditto
Magnesite with talc lenses in situ	Kharidhunga	Steep to very steep, dissected mountainous areas
Alluvium/colluvium derived from chlorite schist; talc and iron oros	Khari, Mane	Nearly level bench terraces in rolling basin, probably of a synelinorium type

Note: Golme Danda, Lapse and Sarai Danda series occur on both bench terraces and non-terraced slopes.

Table 4.15. Monthly rainfall, runoff and soil loss at Dandapakhar (1984/ 1985) and Bonch (1985)
Tab. 4.15. Monatlicher Niederschlag, Abfluss und Boden-Abtrag in Dandapakhar (1984/1985) und in Bonch (1985)

Testplots Dandapakhar

Experiment	1984 / Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Rainfall	Amount (mm)	20	31	9	126	274	555	958	529	436	53	0	8	2999
	Erosivity (10^{-2} $Joules.m^{-2}.cm.h^{-1}$)	-	-	-	?	189.8	378.0	461.4	281.7	138.8	21.8	-	-	1471.5
Plot 1 (bare)	Runoff ($m^3.h^{-1}$)													5598
	Runoff (% rainfall)	-	-	-	?	21.7	24.6	24.1	19.5	6.8	-	-	-	18.7
	Soilloss ($t.ha^{-1}$)	-	-	-	?	10.3	3.2	1.8	0.8	0.1	-	-	-	16.2
Plot 2 (overgrown)	Runoff ($m^3.h^{-1}$)													5303
	Runoff (% rainfall)	-	-	-	?	24.9	25.7	22.9	14.0	5.9	-	-	-	17.7
	Soilloss ($t.ha^{-1}$)	-	-	-	?	2.7	0.4	0.2	0	0	-	-	-	3.3

Experiment	1985 /Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Rainfall	Amount (mm)	17	13	2	30	120	425	1048	839	440	252	11	54	3251
	Erosivity (10^{-2} $Joules.m^{-2}.cm.h^{-1}$)	-	-	-	-	78.8	300.2	430.6	532.1	187.2	92.3	-	-	1621.2
Plot 1 (bare)	Runoff ($m^3.h^{-1}$)													2454
	Runoff (% rainfall)	-	-	-	-	3.9	16.9	5.6	7.8	8.6	4.0	-	-	7.8
	Soilloss ($t.ha^{-1}$)	-	-	-	-	1.3	2.4	1.4	0.3	0	0	-	-	5.4
Plot 2 (overgrown)	Runoff ($m^3.h^{-1}$)													277
	Runoff (% rainfall)	-	-	-	-	0	2.1	0.9	0.2	1.3	0.4	-	-	0.9
	Soilloss ($t.ha^{-1}$)	-	-	-	-	0.1	0.1	0.2	0	0	0	-	-	0.4

Testplots Bonch

Experiment	1985 / Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Rainfall	Amount (mm)	15	25	7	93	246	420	910	1000	605	268	8	64	3661
	Erosivity (10^{-2} $Joules.m^{-2}.cm.h^{-1}$)	-	-	-	50.8	94.5	178.6	375.2	767.9	338.8	107.1	-	-	1912.9
Plot 1 (bare)	Runoff ($m^3.h^{-1}$)													9001
	Runoff (% rainfall)	-	-	-	22.4	23.7	17.1	18.6	36.2	26.4	21.9	-	-	25.1
	Soilloss ($t.ha^{-1}$)	-	-	-	13.7	15.5	7.2	7.8	11.5	9.0	1.9	-	-	66.6
Plot 2 (overgrown)	Runoff ($m^3.h^{-1}$)													2466
	Runoff (% rainfall)	-	-	-	21.1	13.9	10.1	6.0	6.6	3.8	3.2	-	-	6.9
	Soilloss ($t.ha^{-1}$)	-	-	-	2.7	0.9	0.1	0	0	0	0	-	-	3.7